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SOME MOLLUSKS FROM AFGHANISTAN

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INTRODUCTION

Materials collected by the William S. and Janice K. Street Expedition to Afghanistan in 1965 (see Hassinger, 1968, for an itinerary and discussion of localities) and by Louis Dupree from Aq Kupruk Cave near Sholgara, Balkh Province, totalled 9,816 specimens representing 37 species and varieties. All specimens are deposited in Field Museum of Natural History, hereafter abbreviated FMNH. *Deroceras laeve* (Müller) and *Lytopelte (Liolytopelte) kandaharensis* (Altena, 1970) have been reported on previously (Altena, 1970, 1975). The remaining 35 taxa are discussed below.

An additional three species, *Pupilla afghanicum, Subzebrinus streeti,* and *Syama cavicula,* are described as new; six taxa, *Indoplanorbis exustus* (Deshayes, 1834), *Oxyloma indica* (Pfeiffer, 1849), *Pupisoma orcula* (Benson, 1850), *Vallonia mionecton schamhalensis* (Rosen, 1892), *Subzebrinus tandjanensis* (Kobelt, 1902), and *Parvatella flemingi* (Pfeiffer, 1857), had not been recorded previously from Afghanistan; and four taxa, *Gabbia sistanica* (Annandale & Prashad, 1919), *Polypylis calathus* (Benson, 1850), *Granopupa granum* (Draparnaud, 1801), and *Lamellidens testudinarius* variety *rhadinaeus* (Annandale & Prashad, 1919) although recorded in the older literature, were not taken during the extensive Russian survey of the Afghanistan molluscan fauna reported on by Likharev & Starobogatov (1967). Thus, 14 of the 37 records represent significant faunistic additions.

Perhaps the greatest value of the Street collection is the opportunity it presented to dissect and illustrate the anatomy of several poorly known taxa. Unfortunately, so little information has been recorded on the anatomy of Central Asian mollusks that a comparative basis is lacking for the dissected *Parvatella* and *Parmacella.* For the latter species, comments on its pattern of body organ compaction provide interesting contrasts with slug-like taxa reported on by Solem (1966). Comparisons of *Oxyloma indica* with European suc-

cineids suggest further studies. The long awaited review of the Russian helicoid land snails by Schileyko (1978) permitted a much firmer basis for evaluating the anatomy of several Afghanistan helicids.

A preliminary report on the chronological variation among mollusks at Aq Kupruk cave (Solem, 1972) is supplementary to this report, which ranges in degree of sophistication from a simple listing of geographic records for shell morphs to fairly comprehensive accounts of genital anatomy in little known groups.

PREVIOUS STUDIES

The earliest literature on Afghanistan mollusks consists of the inevitable scattered descriptions of materials gathered on various military expeditions. Only the reports of Hutton (1834, 1849-1850), who recorded 21 species, and Ancey (1893), who listed 27 taxa, are at all comprehensive. Annandale & Prashad (1919) issued a voluminous report on fresh water collections from the southwestern deserts, and Jaeckel (1956) recorded 27 species taken by an entomological survey team (see Klapperich, 1954). Jaeckel (1956, p. 352) summarized previous work, evaluated records, and concluded that there were 37 species known from Afghanistan. Likharev & Starobogatov (1967) had available extensive materials taken from 127 collecting stations between 1957 and 1962. Their report covered 53 species represented by new material, with an additional 14 names carried over from earlier reports, but not verified from their collecting.

It is obvious that knowledge of the Afghanistan molluscan fauna is in a very preliminary stage. The same statements apply to surrounding areas, with the exception of Russia, where the summary volumes of Likharev & Rammel'meier (1962) and Schileyko (1978) provide a solid basis of comparative knowledge.

SYSTEMATIC REVIEW

Citations have been restricted to original descriptions and/or illustrations, major references in literature to Afghanistan records, or significant modern reviews. No attempt at presenting a comprehensive literature review has been made.

The sequence of taxa follows standard classifications.

Class Bivalvia
Family Unionidae
Subfamily Unioninae

Lamellidens testudinarius (Spengler), variety **rhadinaeus** Annandale & Prashad, 1919.

Lamellidens marginalis rhadinaeus Annandale & Prashad, 1919, Rec. Indian Mus., **18**, (1), pp. 59-62, fig. 9, pl. 3, figs. 9-10, pl. 8, fig. 7-11—Jellalabad, Hamun near Lab-i-Baring, Nasratabad, Sistan.

Lamellidens marginalis (Lamarck), Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 351; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 191.

Lamellidens testudinarius (Spengler), Haas, 1969, Das Tierreich, **88**, pp. 110-111.

Record.—10 miles south of Qala-i-Kang, 518 m. elevation, Chakhansoor Prov. (2 juvenile specimens, FMNH 147104).

Remarks.—Two young specimens, one 10.3 mm. long, the other 13.8 mm. long, are referable to this species, which is widely distributed in Pakistan, India, and Ceylon. It is not known from most of Iran. Only the original record from Sistan lies within the Iranian border.

Family Corbiculidae

Corbicula fluminalis (Müller, 1774)

Tellina fluminalis Müller, 1774, Verm. terr. et fluv. hist., **2**, pp. 205-206—Euphrates River.

Corbicula fluminalis (Müller), Annandale & Prashad, 1919, Rec. Indian Mus., **18**, (1), p. 58, pl. 8, figs. 1-6—Seistan, Baluchistan, Afghanistan; Jaeckel, 1956, Mitt.

Zool. Mus. Berlin, 32, (2), p. 351—Kandahar-Kuna; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk. SSSR, 42, p. 192—near Kalat, Afghanistan.

Records.—10 miles south of Qala-i-Kang, 518 m. elevation, Chakhansoor Prov. (10 pairs and 4 valves, FMNH 147089, FMNH 147110); irrigation canals, Arghandab drainage, Kandahar, Kandahar Prov. (1 pair and 87 valves, FMNH 147116, FMNH 147126-7, FMNH 147129).

Remarks.—The many scattered valves from Kandahar encompass the range of variation illustrated by Annandale & Prashad (1919, pl. 8, figs. 1-6). The largest individual was 29.2 mm. in maximum dimension, only 1.7 mm. larger than the maximum reported by Annandale & Prashad (loc. cit.) for Sistan specimens. The shells from Qala-i-Kang are juveniles, the largest reaching only 14.9 mm. in maximum diameter.

Class Gastropoda
Subclass Prosobranchia
Family Viviparidae
Genus **Bellamya** Jousseaume, 1886

The basic generic revision of the Asian Viviparidae by Prashad (1928) has been modified by the subsequent studies of Rohrbach (1937) and Haas (1939). Reference of the Asian species to the African *Bellamya* has been neither confirmed nor disproved by anatomical investigations. I chose to follow a conservative classification and use the broadly defined *Bellamya* as generic reference.

No preserved specimens of the Afghanistan species were available for study. Since the Eastern European distributional limit of *Viviparus* is the Caspian Sea (see Zhadin, 1965, pp. 168-169), and no viviparids have been reported between there and the Afghan-Iran border, I am referring these populations to *Bellamya.* Whether the lack of banding on the apical whorls will be confirmed as a subfamily character seems doubtful.

Starmühlner & Edlauer (1957, p. 443) reported shells from the Iranian portion of the Hamun swamp complex as *Viviparus variatus* Frauenfeld, a species from Southern India, particularly Pondicherry and Madras. I have not seen these specimens, but I suspect that they probably were misidentified and are *B. hilmendensis* (Kobelt).

Bellamya hilmendensis (Kobelt, 1908) Figure 1b,c.

Vivipara (dissimilis var. ?) *hilmendensis* Kobelt, 1908, Syst. Conch. Cab., I, 21, A, pp. 289-290, pl. 59, figs. 9-12—Hilmend, Sistan.

Vivipara hilmendensis Kobelt, Annandale & Prashad, 1919, Rec. Indian Mus., **18**, (1), pp. 27-28—Nasratabad, Jellalabad, Hamun near Lab-i-Baring, Chilling, Sistan; Prashad, 1928, Mem. Indian Mus., **8**, (4), p. 166; Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 338.

Bellamya hilmendensis (Kobelt), Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 168.

Record.—10 miles south of Qala-i-Kang, 518 m. elevation, Chakhansoor Prov. (88 specimens, FMNH 147084, FMNH 147091, FMNH 147096, FMNH 147098, FMNH 147108, FMNH 147112-4).

Remarks.—Only a single juvenile of less than 5 mm. was collected alive, although several other individuals had the operculum in place.

Most examples were juvenile; less than a dozen would be considered adult. The largest was 31.8 mm. high, 24.0 mm. in diameter, with 7 whorls. This is about 18% larger than the types. Juvenile shells (fig. 1c) have extremely narrow apical whorls and the periphery is markedly angulated. Adult shells (fig. 1b) generally have the apical whorls eroded (as in the type illustrations) and very deep sutures.

Family Bythiniidae

Gabbia sistanica (Annandale & Prashad, 1919). Figure 1a.

Amnicola (Alocinma) sistanica Annandale & Prashad, 1919, Rec. Indian Mus., **18**, (1), pp. 23-27, figs. 1-2, pl. 3, figs. 1-5—northern Sistan, living in Hamun near Lab-i-Baring.

Bithynia (Alocinma sistanica) (sic) (Annandale & Prashad), Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), pp. 338-339.

Allocinma (sic) sistanica Annandale & Prashad, Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 169.

Record.—10 miles south of Qala-i-Kang, 518 m. elevation, Chakhansoor Prov. (98 specimens, FMNH 147086, FMNH 147097, FMNH 147101).

Remarks.—Only dead specimens, many with the operculum in place, were collected. Size variation in the few obviously adult shells is summarized in Table I. They show the same range as the type set. No data are available concerning the extent of sexual dimorphism.

I have followed conservative standard classifications in placing *Alocinma* as a synonym of *Gabbia*. Whether *Bithynia* and *Gabbia* are congeneric is uncertain. Currently available evidence is inadequate to present a meaningful classification.

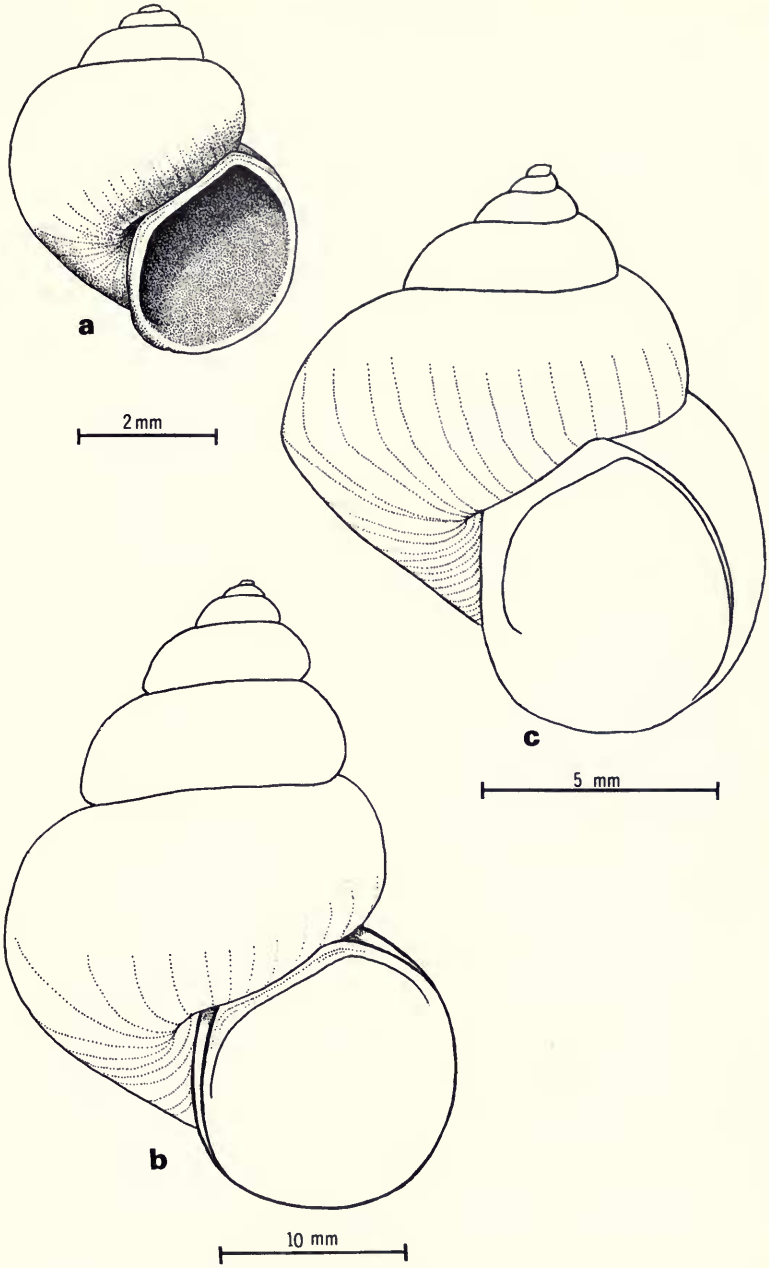

FIG. 1. **a**, *Gabbia sistanica* (Annandale and Prashad), Qala-i-Kang, Chakhansoor Prov., Afghanistan, FMNH 147110; **b-c**, *Bellamya hilmendensis* (Kobelt), Qala-i-Kang, Chakhansoor Prov., Afghanistan, FMNH 147084. *b*, adult; *c*, juvenile. Scale lines as marked.

Table I. - Size variation in Gabbia sistanica

CHARACTER	$\bar{X}$ AND SEM	RANGE
Height	7.65±0.155	7.31-8.02
Diameter	5.74±0.202	5.37-6.27
H/D Ratio	1.34±0.025	1.28-1.40
Whorls	5 3/8-	5 1/4-5 3/8+
Aperture Height	3.43±0.137	3.17-3.75
H/AH Ratio	2.24±0.062	2.07-2.37

An outline figure of the shell has been presented for comparison with illustrations of Iranian hydrobiiform taxa (see Starmühlner & Edlauer, 1957, pl. 1).

Superorder Basommatophora
Superfamily Lymnaeacea
Family Lymnaeidae

Identification of Central Asian Lymnaeidae is impossible on a meaningful basis. Annandale & Prashad (1919) recognized six species and one variety from Baluchistan and Sistan. Hubendick (1951) considered five of these to be forms intermediate between races of the Palearctic *Lymnaea auricularia*. The two others were added to the synonymy of *L. truncatula*. Although I have utilized Hubendick's concepts, this was done with considerable reservations. Likharev & Starobogatov (1967, pp. 170-172) report six species from Afghanistan and give some anatomical data on two species. Without extensive material from the U.S.S.R. and India, plus much more abundant collections from Afghanistan and Iran, no definitive treatment will be possible. The following records serve only to establish the presence of generalized morphotypes in the particular area. They should not be taken as indicating firm species records to be used in range compilations. For convenience, outline figures of the three morphs are given.

Lymnaea truncatula (Müller, 1774). Figure 2c.

Buccinum truncatulum Müller, 1774, Verm. terr. et fluv. hist., **2**, pp. 130-131—Denmark.

Lymnaea truncatula (Müller), Hubendick, 1951, K. Sven. Vetenskapsakad. Handl., **3**, (1), pp. 122-124, figs. 306-307; Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 339—Kabul; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 172—numerous records.

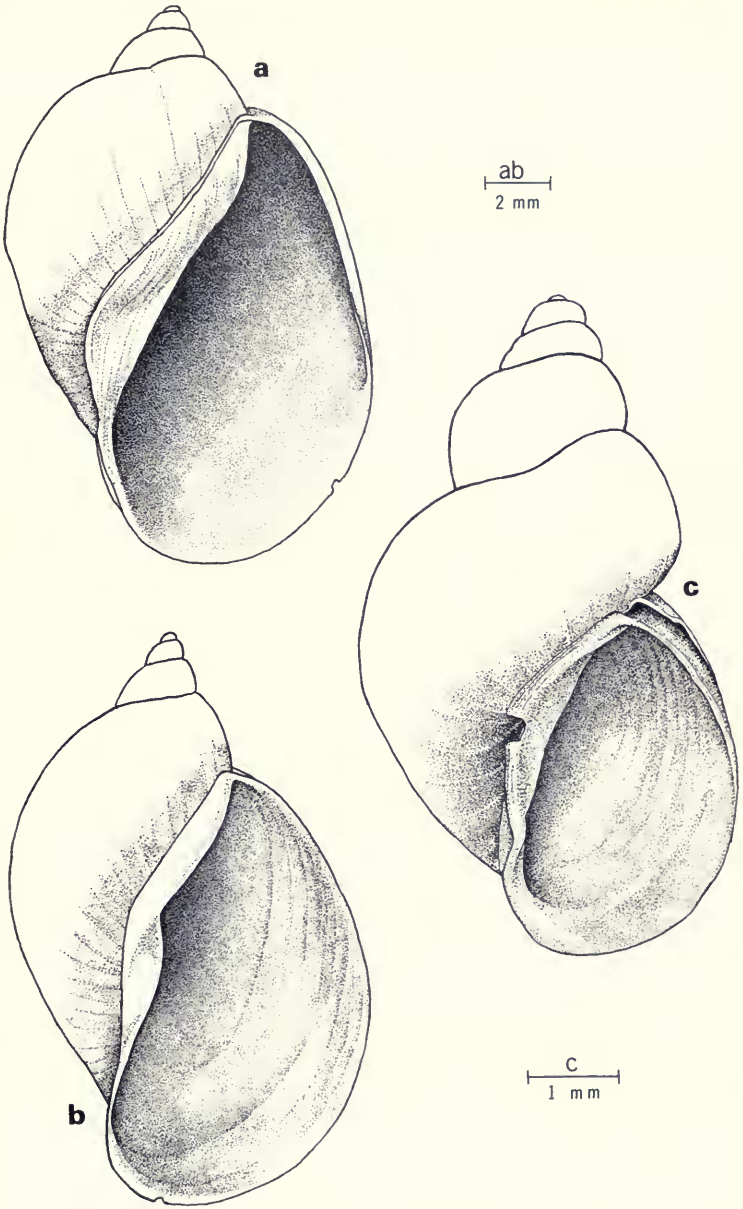

FIG. 2. **a**, *Lymnaea auricularia* var. *persica* Issel, South of Ishkamish, Badakshan Prov., Afghanistan, FMNH 147133; **b**, *Lymnaea auricularia* var. *gedrosiana* Annandale & Prashad, Qala-i-Kang, Chakhansoor Prov., Afghanistan, FMNH 147090; **c**, *Lymnaea truncatula* (Müller), Shibar Pass, Parwan Prov., Afghanistan, FMNH 147175. Scale lines as marked.

Records.—Paghman, 2,400 m. elevation, Kabul Prov. (7 speci mens, FMNH 147083); along stream in cultivated valley, Bamiyan 2,800 m. elevation, Bamiyan Prov. (17 specimens, FMNH 147137 FMNH 147139); rodent burrow in Shibar Pass, 2,745 m. elevation Parwan Prov. (1 specimen, FMNH 147175).

Remarks.—Recovery of a living specimen 6.9 mm. long from rodent burrow in the Shibar Pass (FMNH 147175) was unexpected The shell was the angulated variant frequently found in lymnaeid raised under adverse conditions. Presumably, it was accidentall transported from nearby water on the rodent's fur. The larges Paghman specimen was 8.75 mm. long (FMNH 147083), whereas the largest from Bamiyan was only 6.4 mm. long. I do not know whether these are age correlated or ecophenotypic differences.

Lymnaea auricularia (Linné, 1758). Figure 2a,b.

Helix auricularia Linné, 1758, Syst. Nat., ed. 10, p. 774—Sweden.

Lymnaea auricularia (Linné), Hubendick, 1951, K. Sven. Vetenskapsakad. Handl 3, (1), pp. 149-158, figs. 335-344.

Lymnaea auricularia gedrosiana Annandale & Prashad, Jaeckel, 1956, Mitt. Zoo Mus. Berlin, 32, (2), pp. 339-340—Kabul.

Records.—Variety *persica* Issel: 29 km. southwest of Ishkamish at 2,653 m. elevation, Badakshan Prov. (19 specimens, FMNH 147133).

Variety *gedrosiana* Annandale & Prashad: 10 km. south of Qala i-Kang, 518 m. elevation, Chakhansoor Prov. (54 specimens, FMNH 147088, FMNH 147090, FMNH 147094, FMNH 147106-7, FMNH 147109, FMNH 147111); 29 km. southwest of Ishkamish, 2,653 m elevation, Badakshan Prov. (1 specimen, FMNH 147134); alon stream in cultivated valley, Bamiyan, 2,800 m. elevation, Bamiya Prov. (1 specimen, FMNH 147138); Shibar Pass, fast-runnin stream at 2,745 m. elevation, Parwan Prov. (30 specimens, FMNH 147174).

Remarks.—Although Annandale & Prashad (1919) recognize *Lymnaea gedrosiana, L. gedrosiana rectilabrum, L. bactriana, L. persica,* and *L. iranica* as distinct taxa, Hubendick (1951) considere them to be forms of the *Lymnaea auricularia* superspecies. Starmühlner & Edlauer (1957, pp. 461-462) followed Hubendick. I recognize forms *persica* and *gedrosiana* in the available material (fig 2a-b).

Specimens from Ishkamish (FMNH 147133) are referred to variety *persica* and reach 20.3 mm. in height. The largest *gedrosian*

are from the Shibar Pass and reach 18.3 mm. in height. These are larger than the examples recorded by Annandale & Prashad (1919, pp. 43, 48) from Sistan, but come from wetter areas. Specimens from Qala-i-Kang are much smaller and fall within the size range of the *gedrosiana* types.

Family Planorbidae

The six or seven species reported from Afghanistan are quite distinctive in appearance and can be separated by the following key, which includes all recorded species, not just the four represented in these collections. *Indoplanorbis exustus* is recorded from Afghanistan for the first time. Whether the material reported by Jaeckel (1956, p. 340) as *Planorbis planorbis* (Linné) and by Likharev & Starobogatov (1967, pp. 172-175) as *Planorbis sieversi* (Mousson) should be referred to the same taxon is uncertain.

Key to the Afghanistan Planorbidae

1. Diameter of shell more than 6 mm. at 3 whorl stage 2
   Diameter of shell less than 4 mm. at 3 whorl stage 3
2. Shell inflated; height about half diameter.
   Indoplanorbis exustus (Deshayes, 1834)
   Shell flattened, height about one-quarter diameter.
   Planorbis planorbis (Linné, 1758) or *P. sieversi* (Mousson, 1873)
3. Umbilicus broadly open, very shallow; whorls not overlapping 4
   Umbilicus narrow, deep; whorls strongly overlapping on spire.
   Polypylis calathus (Benson, 1850)
4. Surface of shell smooth or with radial growth striae 5
   Surface with prominent radial ribs; diameter less than 2 mm.
   Armiger annandalei (Germain, 1923)
5. Periphery usually rounded; adult size up to 5 mm.; surface relatively smooth ..... *Gyraulus convexiusculus* (Hutton, 1850)
   Periphery usually angulated; adult size up to 6.2 mm.; surface with marked radial growth striae ..... *Gyraulus euphraticus* (Mousson, 1874)

Subfamily Bulininae

Indoplanorbis exustus (Deshayes, 1834)

Planorbis exustus Deshayes, 1834, Voy. Bell. Indes Orient., Zool., **3**, p. 417, pl. 1, figs. 11-13; Preston, 1915, Fauna of British India, Mollusca, **3**, pp. 115-116.

Indoplanorbis exustus (Deshayes), Annandale et al., 1921, Rec. Indian Mus., **22**, (4), pp. 580-582.

Record.—10 miles south of Qala-i-Kang, 518 m. elevation, Chakhansoor Prov. (17 specimens, FMNH 147087, FMNH 147095, FMNH 147099, FMNH 147105).

Remarks.—Seventeen dead examples of various ages came from the Helmand River flood plain. The largest example was 13.9 mm. in diameter and 6.4 mm. high, substantially below the normal size in Indian specimens. Although I have seen material labeled "Afghan frontier" (FMNH 112957), these are the first published records for Afghanistan.

Subfamily Planorbinae

Gyraulus convexiusculus (Hutton, 1850)

Planorbis convexiusculus Hutton, 1850, Jour. Asiatic Soc. Bengal, (2), **18**, p. 657—Candahar, Quettah, Kojuck Pass, River Helmund at Girishk, Afghanistan.

Planorbis (Gyraulus) convexiusculus Hutton, Preston, 1915, Fauna British India, Mollusca, **3**, pp. 118-119.

Gyraulus convexiusculus (Hutton), Annandale & Prashad, 1919, Rec. Indian Mus., **18**, (1), pp. 52-54, fig. 7B—Sistan and Quetta; Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2) p. 340—Kandahar, Scham-Schir-Ror, 50 km. west of Kandahar, Kabul.

Anisus (Gyraulus) convexiusculus (Hutton), Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, pp. 175-176, figs. 7-8—many localities.

Records.—10 miles south of Qala-i-Kang, 518 m. elevation, Chakhansoor Prov. (33 specimens, FMNH 147092-3, FMNH 147100); bank of irrigation ditch, 7 miles south of Herat, 915 m. elevation, Herat-Kandahar Road, Herat Prov. (1 specimen, FMNH 147152); gardens near Kandahar, 1,425 m. elevation, Kandahar Prov. (1 specimen, FMNH 147125); 29 km. southwest of Eshkershem, 2,653 m. elevation, Badakshan Prov. (1 specimen, FMNH 147135); along stream in cultivated valley, Bamiyan, 2,800 m. elevation, Bamiyan Prov. (2 specimens, FMNH 147140).

Remarks.—Considerable confusion exists concerning the identity of Palearctic and Oriental *Gyraulus*. I have accepted Annandale and Prashad's division of forms into *G. convexiusculus* and *G. euphraticus,* but it is quite possible that *G. convexiusculus* is a mixture of two or more species. Most of the material available to me was collected from river drift. It is not adequate to resolve this problem.

Most specimens are distinctly smaller and less sharply angulated than examples of *G. euphraticus* with comparable whorl counts, but some worn shells could be placed in either species.

Gyraulus euphraticus (Mousson, 1874) (=*Planorbis compressus* Hutton, 1834, not Michaud, 1831)

Gyraulus euphraticus (Mousson), Annandale & Prashad, 1919, Rec. Indian Mus., **18** (1), pp. 54-56, fig. 7A—Quetta; Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 340—Kandahar.

Anisus (Gyraulus) euphraticus (Mousson), Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 177—Fariab, Badghis and Herat Provinces, Afghanistan.

Record.—10 miles south of Qala-i-Kang, 518 m. elevation, Chakhansoor Prov. (56 specimens, FMNH 147085, FMNH 147103).

Remarks.—*Gyraulus euphraticus* is recognized by its marked peripheral angulation, rougher surface, and larger size. Radular and habitat differences are cited by Annandale & Prashad (loc. cit.). Probably this species ranges from "Mesopotamia" to Kiangsu Province on the coast of China.

Polypylis calathus (Benson, 1850)

Planorbis calathus Benson, 1850, Ann. Mag. Nat. Hist., (2), **5**, p. 348-349.

Planorbis (Segmentina) calathus Benson, Preston, 1915, Fauna of British India, Mollusca, **3**, p. 127.

Segmentina calathus (Benson), Annandale & Prashad, 1919, Rec. Indian Mus., **18**, (1), pp. 56-57—Peshawar, Northwest Frontier, Gurdaspur, Punjab, Nasratabad, Sistan; Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 340—Kandahar-Kuna, 950 m. elevation.

Polypylis calathus (Benson), Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 178.

Record.—10 miles south of Qala-i-Kang, 518 m. elevation, Chakhansoor Prov. (1 specimen, FMNH 147102).

Remarks.—A single subadult specimen unquestionably is this widely distributed Indian species. The exact relationship of *Segmentina* and *Polypylis* remains uncertain, since the anatomical features offer uncertain phylogenetic evidence (Hubendick, 1955, pp. 532-533). The conchological difference of a less flattened and less carinated shell in *Polypylis* is not a major change.

Superorder Stylommatophora
Order Orthurethra
Superfamily Pupillacea
Family Vertiginidae
Subfamily Nesopupinae

Pupisoma (Ptychopatula) orcula (Benson, 1850)

Helix orcula Benson, 1850, Ann. Mag. Nat. Hist., (2), **6**, p. 251-252—road from Jounpore to Benares, India.

Pupisoma orcula (Benson), Gude, 1914, Fauna of British India, Mollusca, **2**, pp. 36-37; Pilsbry, 1920, Man. Conch., (2), **26**, (1), pp. 31-36, pl. 2, figs. 1-5.

Record.—Dilaram, 854 m. elevation, Farah Prov. (1 specimen, FMNH 147143).

Remarks.—A single broken specimen is the first Afghanistan record for this widely distributed Indo-Malayan species. It has been accidentally introduced into many areas on plants.

Subfamily Chondrininae

Granopupa granum (Draparnaud, 1801). Figure 3.

Pupa granum Draparnaud, 1801, Tab. Moll. France, p. 59—France.

Granopupa granum (Draparnaud), Pilsbry, 1918, Man. Conch., (2), **24**, (4), pp. 335-340, pl. 47, figs. 3, 12; Biggs, 1937, Jour. Conch., **20**, (12), p. 346—Seguch and mountains east of Kerman up to 9,000 ft. elevation, Iran; Starmühlner & Edlauer, 1957, Sitzungsber. Österr. Akad. Wissen., Math.-Naturwiss. Kl., **166**, (9-10), p. 466—Mohamedabad, Iran; Likharev & Rammel'meier, 1962, Keys to the Fauna of the U.S.S.R., **43**, pp. 141-142, fig. 42; Gittenberger, 1973, Zool. Verh. Rijksmus. Nat. Hist. Leiden, **127**, pp. 36-41, figs. 6-8.

Record.—Dry wash in rocky mountain area, Dilaram, 854 m. elevation, Farah Prov. (7 specimens, FMNH 147144).

Extralimital material.—Spain: Torredembarra (7 specimens, FMNH 160002 Georg Scheller! 1961); Molineta, Almeria (45 specimens, FMNH 157101 A. Cobos!). Malta: Wied Dalam (10 specimens, FMNH 17186). Libya: Wadi Millau west of Tohuetta (10 specimens, FMNH 92153 R. Brandt! October 15, 1957); Wadi Haleigh el Asel (9 specimens, FMNH 92148 R. Brandt! March 5, 1958); Wadi Haleigh el Asel (18 specimens, FMNH 92149 R. Brandt! March 5, 1958). Iran: Sejuch (3 specimens, FMNH 147144 H. J. Biggs!).

Remarks.—Many additional sets with relatively poor locality data were examined in the Field Museum collection and showed the same general patterns of variation. The apertural barriers are essentially identical in all examples seen and provide the basis for keeping this as a single species. Size, shape, and shell sculpture showed considerable differences between populations, with the correlations partly ecologic and partly geographic.

Libyan shells are distinctly smaller, but with virtually identical whorl counts when compared with Malta and Spanish specimens. The large set from Almeria does have an increased whorl count comparable with that seen in the few shells from Iran, but the Afghanistan shells have a very low whorl count, although they are second in size only to the Iranian material. The few examples in the

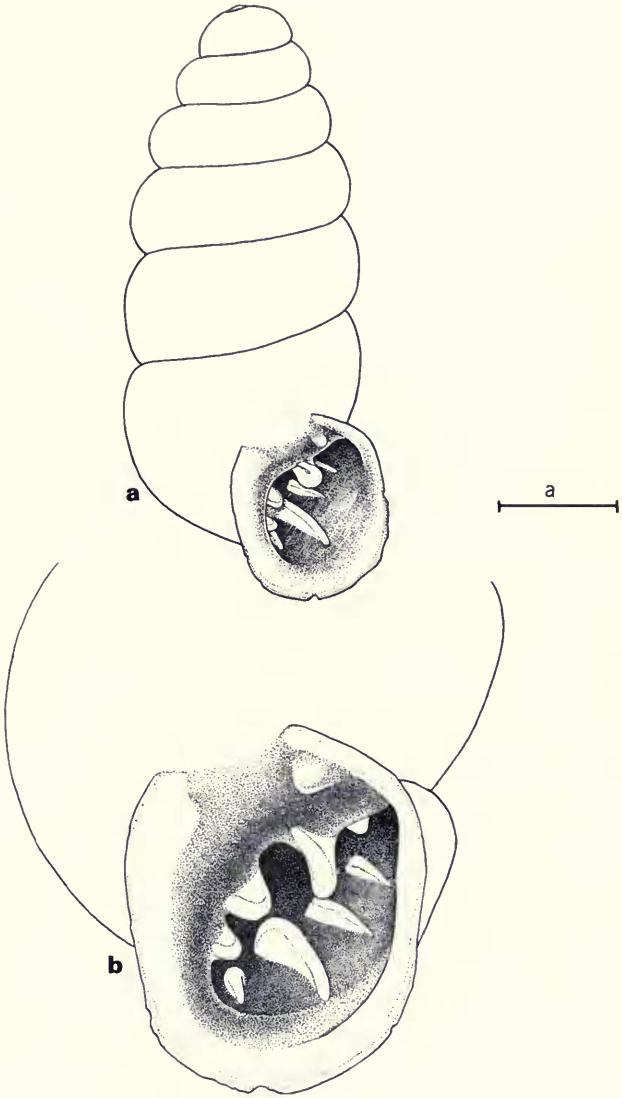

FIG. 3. *Granopupa granum* (Draparnaud), Dilaram, Farah Prov., Afghanistan, FMNH 147144. Scale line equals 1 mm.

latter set were "traded" through shell collectors and probably show size bias, but the larger height of the Afghanistan set is not an artifact. Similarly, the Afghanistan shells are slenderer than those from other areas (see table II).

Specimens from Spain and Malta have quite prominent radial ribbing on the shell surface, whereas those from Iran and Libya have the ribs noticeably reduced in prominence, and those from Afghanistan have only an irregular trace of the radial ribbing. Sculpture reduction seems to correlate with dryness of the area, but the size and shape changes do not demonstrate an ecologic correlation. European collections undoubtedly contain material adequate for a review of geographic variation in this species. The data presented here only serve to introduce this problem for study. Further study and dissection may demonstrate that there is a species complex involved.

Granaria lapidaria (Hutton, 1849)

Pupa lapidaria Hutton, 1849, J. Asiatic Soc. Bengal, **18**, (2), p. 652-653—desert plain of Dusht-i-Be-dowlut at western end of Bolan Pass, Afghanistan.

Abida lapidaria (Hutton), Pilsbry, 1918, Man. Conch., (2), **24**, (4), pp. 330-331, pl. 46, fig. 10; Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 341—Kandahar-Kuna, Afghanistan; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, 42, p. 180.

Remarks.—I had thought that *Pupa lapidaria* Hutton, 1849 is a synonym, although I have not seen either the types or the specimens reported as this species by Jaeckel (1956). Pilsbry (1918, p. 330), with his normal profound intuition, indicated that the obscure *Pupa lapidaria* might be a *Granopupa* rather than an *Abida*. Likharev & Starobogatov (1967, p. 180) did not have any Afghanistan material. Gittenberger (1973, pp. 42-44, fig. 10) showed that it is a distinct species, to be classified as *Granaria lapidaria* (Hutton, 1849).

Subfamily Pupillinae

Pupilla (Gibbulinopsis) afghanicum, new species. Figures 4-6.

Pupilla (Gibbulinopsis) sp., Solem, 1972, Trans. Amer. Philos. Soc., **62**, (4), p. 59.

Diagnosis.—Shell minute, height 1.83-2.11 mm. (mean 1.93 mm.), diameter 0.99-1.05 mm. (mean 1.02 mm.), with 5½ to 6⅛ whorls. Apical whorls 1¾, macroscopically almost smooth, at high magnifications with sculpture of very fine irregular pits in a somewhat glassy amorphous surface with a weakly irregular radial rugose appearance in lateral view (fig. 6a). Postnuclear whorls with high, prominent, protractively slanted radial ribs, somewhat irregularly spaced, whose interstices are 1½-3 times their width. Microsculpture consisting solely of irregular amorphous pitting continu-

Table II. - Size variation in lower Orthurethra

	NUMBER OF SPECIMENS	HEIGHT	DIAMETER	H/D RATIO	WHORLS
Pupilla afghanicum					
FMNH 156412,-17,-98	5	1.93±0.049 (1.83-2.11)	1.02±0.012 (0.99-1.05)	1.89±0.055 (1.79-2.10)	5 5/8+(5 1/2-6 1/8)
Granopupa granum					
Libya					
FMNH 92153	10	3.58±0.089 (3.13-4.05)	1.50±0.022 (1.41-1.61)	2.39±0.059 (2.02-2.67)	7 1/8-(6 1/2-7 3/4)
FMNH 92148	9	3.59±0.087 (3.29-3.95)	1.51±0.022 (1.41-1.61)	2.38±0.042 (2.17-2.55)	7-(6 5/8-7 3/8)
FMNH 92149	17	3.63±0.065 (3.29-4.18)	1.55±0.019 (1.41-1.71)	2.34±0.041 (2.00-2.61)	7-(6 1/2-7 1/2)
Malta					
FMNH 17186	10	3.93±0.087 (3.52-4.28)	1.62±0.029 (1.48-1.74)	2.43±0.028 (2.35-2.65)	7 1/8-(6 3/4-7 3/4)
Spain					
FMNH 160002	7	4.08±0.109 (3.65-4.38)	1.76±0.026 (1.68-1.84)	2.32±0.043 (2.20-2.51)	7(6 5/8-7 1/4)
FMNH 157101	45	4.39±0.060 (3.49-5.13)	1.72±0.012 (1.55-1.88)	2.55±0.025 (2.08-2.91)	7 1/2-(6 3/4-8 3/8)
Persia					
FMNH 128868	3	5.25±0.067 (5.16-5.33)	2.13±0.029 (2.07-2.17)	2.47±0.050 (2.42-2.57)	7 3/8+(7 1/4-7 5/8)
Afghanistan					
FMNH 147144	6	4.93±0.100 (4.61-5.26)	2.28±0.027 (2.17-2.37)	2.17±0.050 (1.94-2.29)	6 5/8+(6 1/2-6 7/8)
Pupoides coenopictus					
FMNH 155938	1	5.10	2.37	2.15	5 3/4

ing across rib surfaces. First 2 whorls widening rapidly, 3rd and 4th only slightly, body whorl slightly tightened in coiling. Sutures deep, whorls strongly and evenly rounded. Aperture subcircular, lip slightly reflected on outer margins, not continuous across parietal wall where it is replaced by a thin to moderately thick callus. Parietal wall with a single, crescentric, short, rather low, very deeply recessed parietal barrier. Columellar wall (fig. 4b) with broadly nodular barrier recessed to posterior margin of columellar wall. Lower palatal barrier a pyramidal to elongately ovate ridge recessed almost $^3/_{16}$ of a whorl behind lip edge.

Pupilla afghanicum is separated from *P. annandalei* Pilsbry, 1921 by its much smaller size, absence of a nodular angular, smaller barriers, more strongly rounded whorls, and more prominent radial ribbing. *Pupilla eurina* (Benson, 1864) is much larger and has over 7 whorls. Other Asian *Pupilla* are much larger and have more barriers with much less prominent sculpture.

Description.—Shell minute with 5½ whorls. Apical whorls 1¾, together with first postnuclear whorl widening rapidly, remaining whorls until start of body whorl coiled in same plane, body whorl coiling somewhat constricted. Sculpture as in diagnosis. Whorls strongly rounded, sutures deep, not constricted behind lip at site of palatal barrier. Aperture subcircular, slightly ascending at front. Peristome slightly expanded on outer margins, more strongly rolled on lower palatal wall, connected across parietal wall by a relatively thin callus. Parietal barrier smaller than usual, crescentric, deeply recessed. Columellar barrier as in diagnosis. Lower palatal barrier a circular knob, recessed $^3/_{16}$ of a whorl. Height of holotype 1.91 mm., diameter 1.05 mm., H/D ratio 1.81.

Holotype.—Afghanistan: Snake Cave, Aq Kupruk I, Cut 5p at 250 cm. transitional gravels, at 760 m. elevation. 36° 5′ N, 66° 51′ E. FMNH 160023.

Paratypes.—Total of 17 adult and fragmentary examples from the Aq Kupruk deposits ranging in age from 1,650 to more than 17,000 BC (FMNH 156412, FMNH 156417, FMNH 156426, FMNH 156435, FMNH 156498, FMNH 156764).

Remarks.—Variation in the five adult specimens is summarized in Table II. There is some difference in the relative size of the parietal and lower palatal barriers, but this may be age correlated. Lip reflection does not seem to be very greatly developed in this species. One or two of the "adult" shells with slightly smaller barriers may be subadult.

Differences from *P. annandalei* are given in the diagnosis above. Although reported from "Ava, Burma," probably it was collected in Nepal. Two lost species, *Pupilla seriola* (Benson, 1863) and *Pupilla diopsis* (Benson, 1863) (see Pilsbry, 1920-1921, pp. 204-205) may be related, but until they are rediscovered through new collections,

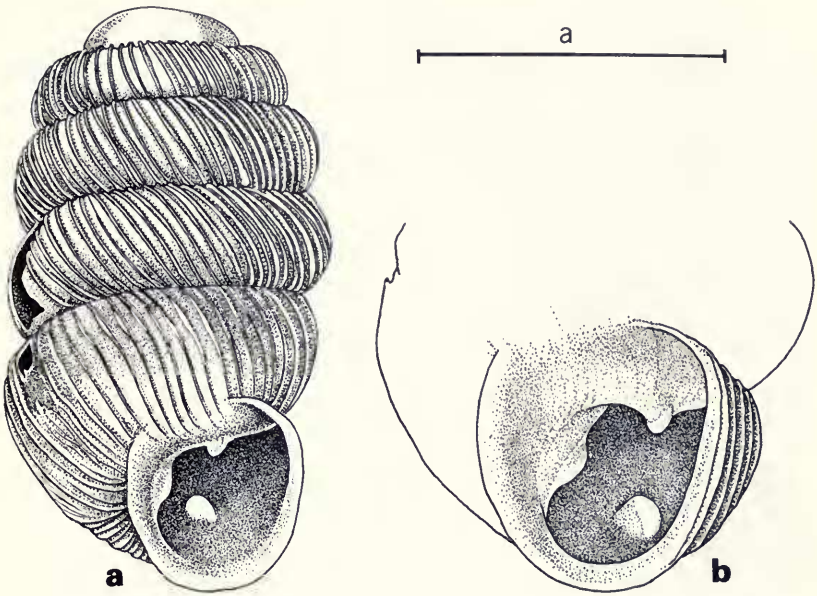

FIG. 4. *Pupilla (Gibbulinopsis) afghanicum*, new species, Aq Kupruk I, Cut 5p, Afghanistan, Holotype, FMNH 160023. Scale line equals 1 mm.

they cannot be compared because of inadequate descriptions. Both in its very small size and very strong radial sculpture, *P. afghanicum* is immediately separable from all other described *Pupilla*.

Transcaucasian *Pupilla* are reported from steppe, semidesert, and dry pasture areas. They live in dry plant remains and under stones or gravel (see Likharev & Rammel'meier, 1962, pp. 161-164). Undoubtedly, this species has been overlooked in recent collections because of its very small size. Only the accidental retention of dirt within the aperture of *Leucozonella* from the cave deposits enabled recovery of these specimens.

Scanning electron microscope studies of this species showed (figs. 5, 6) the apical whorls with weak pitting (fig. 6b) and a secondary rugose sculpture on latter portions (fig. 6a). The basic periostracal pits continue onto the postnuclear whorls. On the sides of the major ribs (fig. 5b), they can be seen to indent the surface quite irregularly. Subsequent examination has shown that this sculpture is characteristic of vertiginids, valloniids, and strobilopsids. Quite

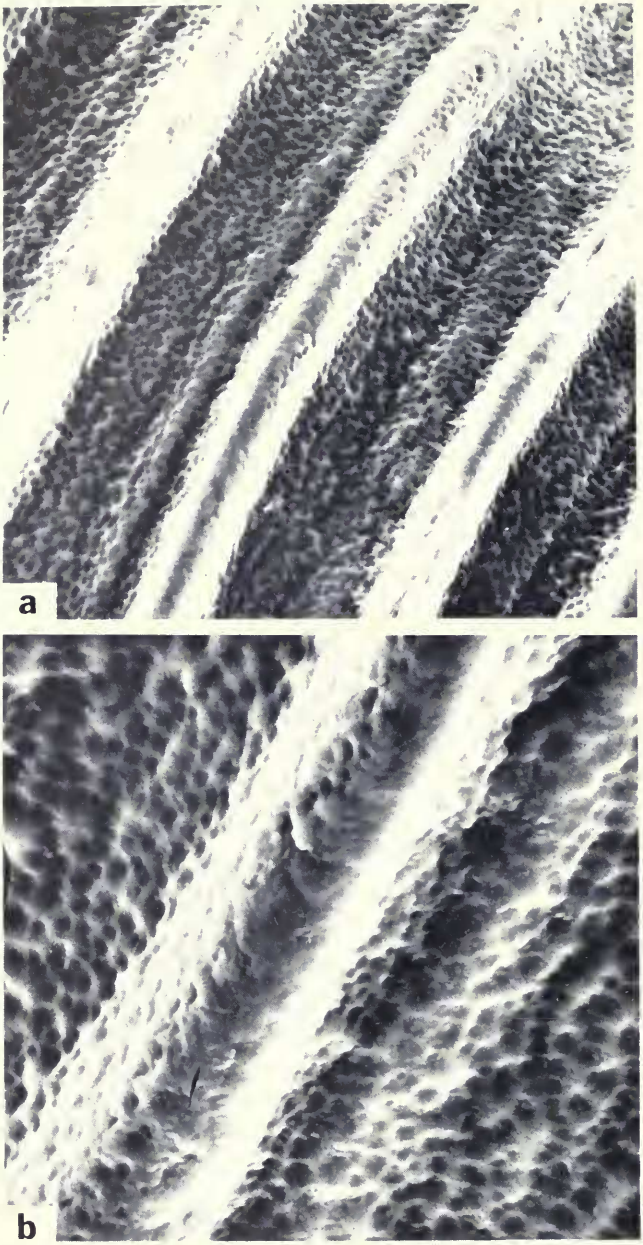

FIG. 5. Postapical sculpture of *Pupilla afghanicum*, Snake Cave, Aq Kupruk I, Cut 5p, Afghanistan, Paratype, FMNH 156498: **a**, parts of four major radial ribs at 1,000×; **b**, one major radial rib and interstice at 3,000×.

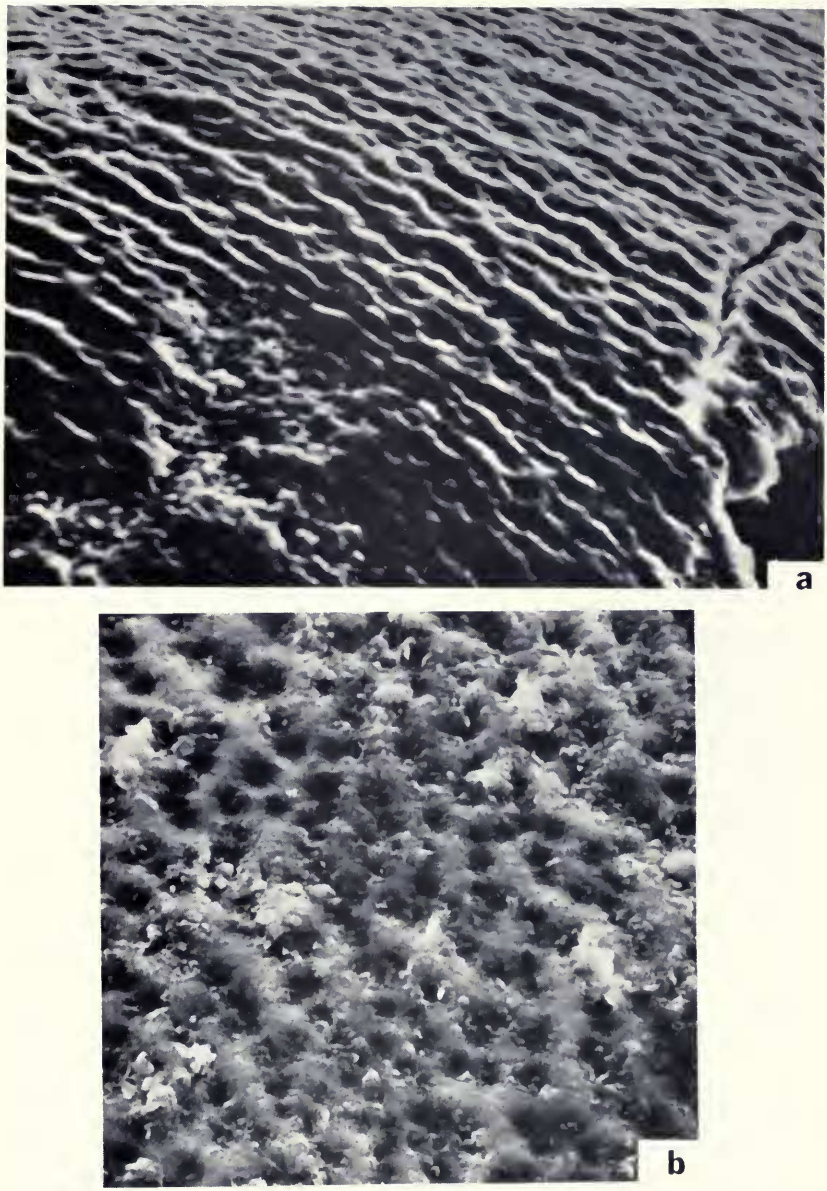

FIG. 6. Apical sculpture of *Pupilla afghanicum*, Snake Cave, Aq Kupruk I, Cut 5p, Afghanistan, Paratype, FMNH 156498: a, lateral view at 2,000×; b, nearly vertical view at 3,000×.

possibly, it will be found to be characteristic of litter-dwelling orthurethrans in general.

Major postnuclear sculpture (figs. 4a; 5a, b) is somewhat variable in width and spacing, but the ribs are alike in being quite elevated, with almost vertical descent until a weak basal flare.

Pupoides coenopictus (Hutton, 1834). Figure 7b.

Pupa coenopicta Hutton, 1834, Jour. Asiatic Soc. Bengal, **3**, pp. 85, 93—Beeana, near Agra, India.

Pupoides coenopictus (Hutton), Pilsbry, 1921, Man. Conch., (2), **26**, (2), pp. 123-129, pl. 13, figs. 1-3; Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 341—Kandahar-Kuna, Afghanistan; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 180—Kajakai, Helmand Prov., Afghanistan.

Record.—Dry wash in boulder-covered montane area, Dilaram, 854 m. elevation, Farah Prov. (1 specimen, FMNH 155938).

Remarks.—The single shell is 5.10 mm. high, 2.37 mm. in diameter, and has 5¾ whorls. It thus matches the measurements cited by Pilsbry (1921, p. 123) for Bombay examples of the typical form and is much larger than form *persicus* Schlesch (1934, p. 45), which is only 4.25 mm. high.

Several specimens of *Granopupa granum* (Draparnaud, 1801) were collected at the same station. They are immediately separable by their greater whorl count and presence of apertural barriers.

Family Valloniidae

Vallonia mionecton schamhalensis Rosen, 1892. Figure 8a-c.

Helix (Vallonia) adela var. *mionecton* O. Böttger, 1889, Zool. Jahrb., Syst., **4**, (5), pp. 941-942, pl. 27, figs. 11a-d—Agh-dagh, Kopet-dagh, 9,000-10,000 ft. elevation; Biggs, 1937, J. Conch., **20**, (12), p. 346—Kerman, Bagh-i-Shahzdeh, Zeyandeh Rud at Isfahan, (5,100 ft.), Deh Bala under stones at 9,500 ft., Iran.

Vallonia mionecton var. *Schamhalensis* Rosen, 1892, Nachr. d. Malak. Gesell., **24**, (7-8), p. 125—Schamhala, Chorossans, Iran; Sterki, 1893, Proc. Acad. Nat. Sci., Philadelphia, **45**, p. 275; Pilsbry, 1892, Man. Conch., (2), **8**, p. 260, pl. 43, figs. 67-69.

Vallonia mionecton schamhalensis Rosen, Zilch, 1969, Arch. Molluskenkd., **99**, (3-4), p. 223, pl. 2, fig. 4.

Record.—Dilaram, 845 m. elevation, Farah Prov. (1 specimen, FMNH 147142).

Remarks.—A single specimen which is 1.32 mm. high, diameter 3.26 mm., H/D ratio 0.404, D/U ratio 3.30, with 3 ⅞ whorls is tentatively referred to this species. The common *Vallonia pulchella* (Mül-

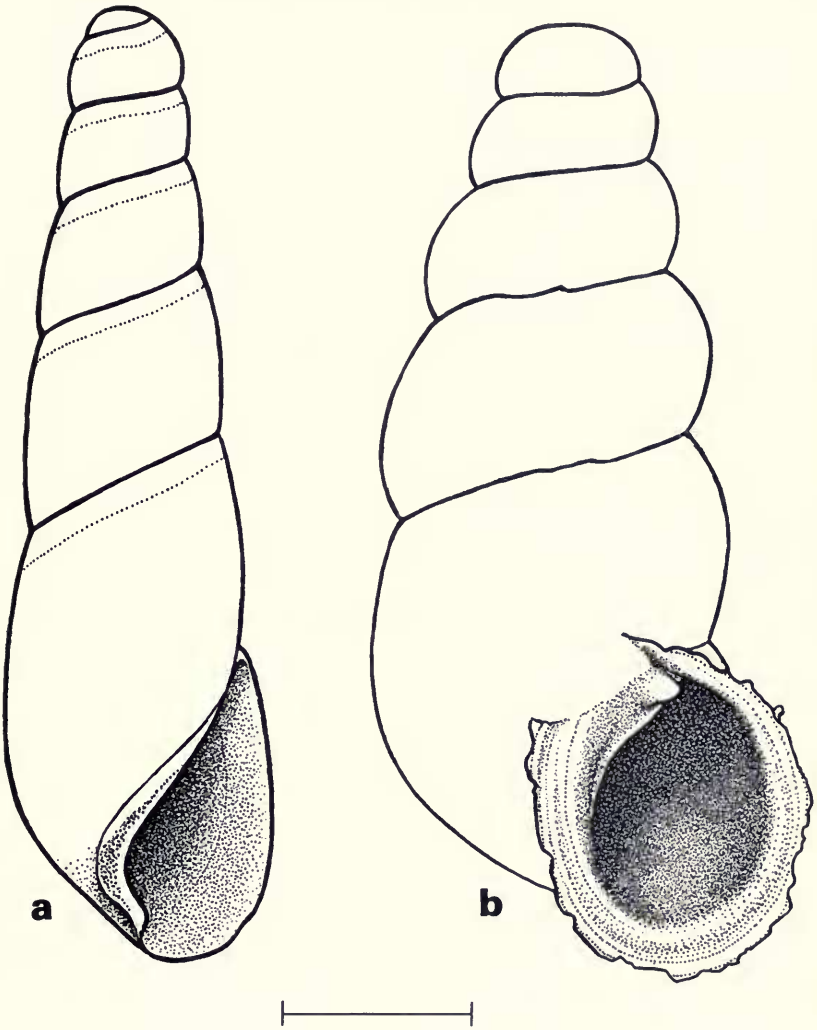

FIG. 7. a, *Caecilioides bensoni* Gude, Aq Kupruk I, Cut 5o, Afghanistan, FMNH 157176; b, *Pupoides coenopictus* (Hutton), Dalaram, Farah Prov., Afghanistan, FMNH 155938. Scale line equals 1 mm.

ler, 1774) which has been recorded from several Afghanistan localities (Jaeckel, 1956, p. 341 and Likharev & Starobogatov, 1967, p. 181), is a much more elevated shell with fatter body whorl and narrower umbilicus. The umbilical width of *V. excentrica* Sterki, 1893 agrees well with that of the Afghanistan shell. Both common

Holarctic species are much smaller with a lower whorl count (mean diameter 1.95-2.71 mm., whorls 3¼ to 3½; see Hubendick, 1950, p. 76 and Hubendick, 1953, p. 227.)

Rosen (loc. cit.) gave no dimensions for *schamhalensis*. Böttger (loc. cit.) cited a diameter of 2⅜ to 2½ mm. with 3½ to 4 whorls for *mionecton*. The larger size of the Afghanistan shell is of uncertain significance. Pending availability of more material, I prefer to utilize a prior name for this shell. Because of their prominent ribbing, neither *V. costata* (Müller) nor *V. tenuilabris* (Braun), both recorded by Likharev & Starobogatov (1967, p. 181), can be confused with this species.

Family Enidae

Genus **Subzebrinus** Westerlund, 1887

Dissection of *Subzebrinus griffithsii* by Hesse (1933) and Jaeckel (1956) classified that species in *Subzebrinus*. Inclusion of the other Afghanistan enids is a matter of convenience. Until they can be dissected, no meaningful generic reference is possible (see Solem, 1964).

Four species were taken by the Street Expedition, *Subzebrinus griffithsii* (Benson, 1848), *S. eremitus* (Benson, 1849), *S. tandjanensis* (Kobelt, 1902), and *S. streeti*, new species. Reference to Table IV and the outlines presented in Figures 9 through 12 show that these species are readily separable by differences in size, shape, and whorl count. The subulinid, *Zootecus insularis chion* (p. 65), is the only species easily confused with enids. It is the same size as *S. tandjanensis*, but averages one more whorl, has a thicker lip, no hydrophanous markings, and the umbilical chink (fig. 26b) is reduced to a narrow suture.

Other enids recorded from Afghanistan include the large, sinistral *Subzebinus candelaris* (Pfeiffer, 1846), the very small *S. drangiana* (Jaeckel, 1956) from Bashgul-Tal, and two unfigured species described by Ancey (1893, pp. 42, 43, 45-47), *S. coelocentrus* and *S. khayberensis*. The types of *S. khayberensis* could not be located by Peter Dance in the Tomlin collection at the National Museum of Wales and the previous efforts to trace them at British Museum (Natural History), Institut Royal des Sciences Naturelles de Belgique, and Muséum National d'Histoire Naturelle, Paris, were equally unsuccessful. Ancey's name is unusable without inspection of the types. Through the kindness of Mr. Dance, it was possible to study and refigure the types of *S. coelocentrus* (figs. 10, 11).

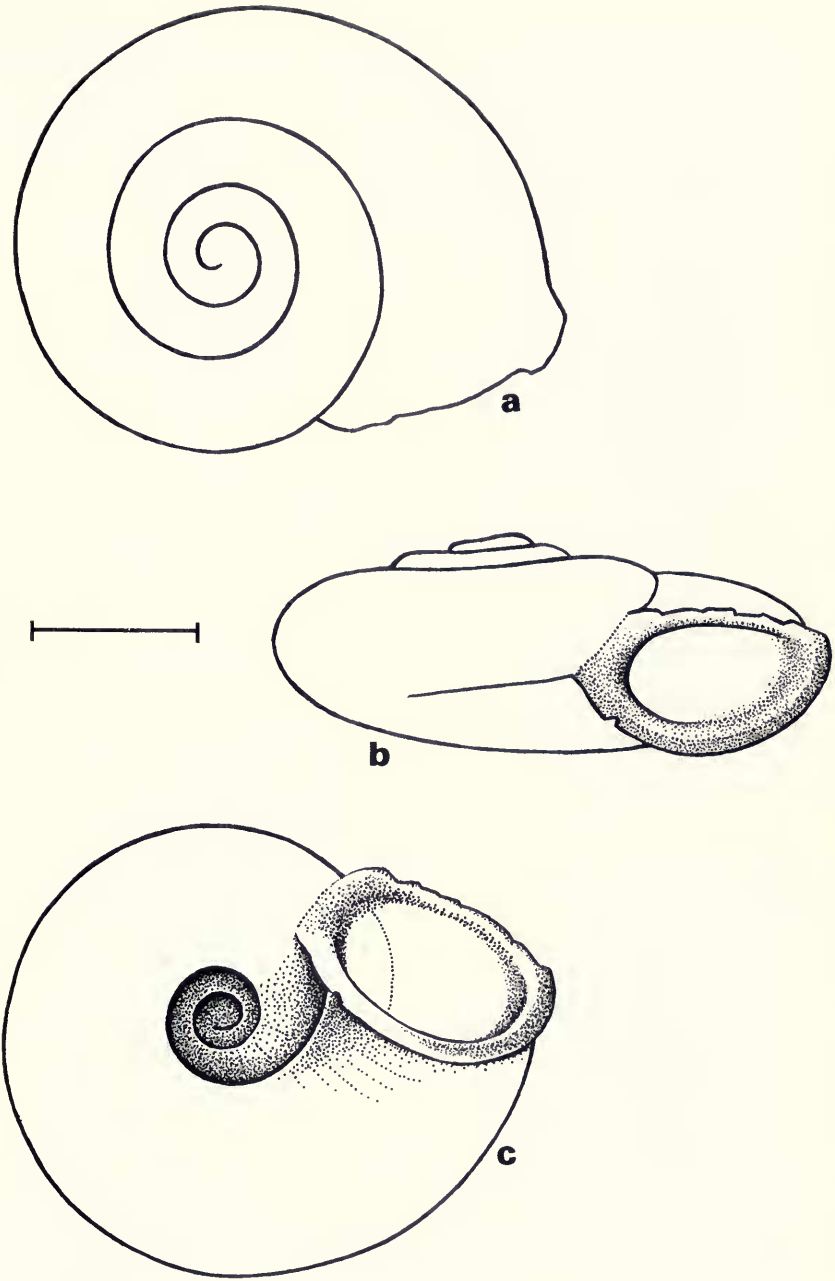

FIG. 8. *Vallonia mionecton schamhalensis* Rosen, Dalaram, Farah Prov., Afghanistan, FMNH 147142. Scale line equals 1 mm.

Early studies were based on, at most, a few specimens from widely separated localities. Hence, little knowledge of variation was accumulated. Matekin (1959) documented the amazing range of variation in Central Asian taxa. Jaeckel (1956, p. 345) presented raw data on altitudinally correlated size variation in *Subzebrinus drangiana,* which I have summarized in Table III. Obviously, size decreases with altitude, those from 1,100 m. averaging almost 24 per cent larger than those taken at 1,500 m. in the same valley. Solem (1972) has reviewed height variations in chronologically separated samples of *S. eremitus* from the Aq-Kupruk caves and found a 16.9 per cent range in mean height. Geographic variation seems even larger, with populations of *S. tandjanensis* showing a 29.0 per cent height range.

Likharev & Starobogatov (1967, pp. 181-185) recorded *Subzebrinus rufistrigatus* (Benson, 1849), *S. potaninianus* (Ancey, 1886), *S. intumescens* (Martens, 1874), *Chondrulopsina fedtschenkoi* (Ancey, 1886), and *C. dentata* Likharev, 1967, in addition to the species mentioned above.

Subzebrinus tandjanensis (Kobelt, 1902). Figure 9a,b.

Buliminus (Subzebrinus) tandjanensis Kobelt, 1902, Syst. Conch. Cab., I, **13**, (2), p. 939, pl. 132, figs. 5, 6—Tandjani-Bergen, North India.

Ena (Serina) tandianensis (sic) (Kobelt), Gude, 1914, Fauna of British India, Mollusca, **2**, p. 255—Tandiani Hills, Punjab (emendation of original spelling).

Records.—5 miles south of Kunduz, 1,800 ft. elevation, wet depressions in heavily irrigated area, Baqhlan Prov. (4 specimens, FMNH 147165); north-facing slope, 25 km. west of Faizabad, 3,300 ft. elevation, Badakhshan Prov. (28 specimens, FMNH 147161, FMNH 147162, SMF).

Remarks.—Although Dr. A. Zilch was unable to locate the types of *Subzebrinus tandjanensis* (Kobelt) in the Natur-Museum Senckenberg, I prefer to place these populations under this name. Tandiani was a hill station at 8,500 ft. elevation in the Hazara area of the Peshawar District in Pakistan near the Kashmir border. Its molluscan fauna was investigated by Theobald (1881), who discovered several new enids. Kobelt (loc. cit.) described this species, and Gude (1914, pp. 257-258) named *Ena hazarica* from the same area. Although these species are very similar in size, differences in shape and sculpture seem to separate them without difficulty. I have not been able to locate Tandiani on any map available to me, and the

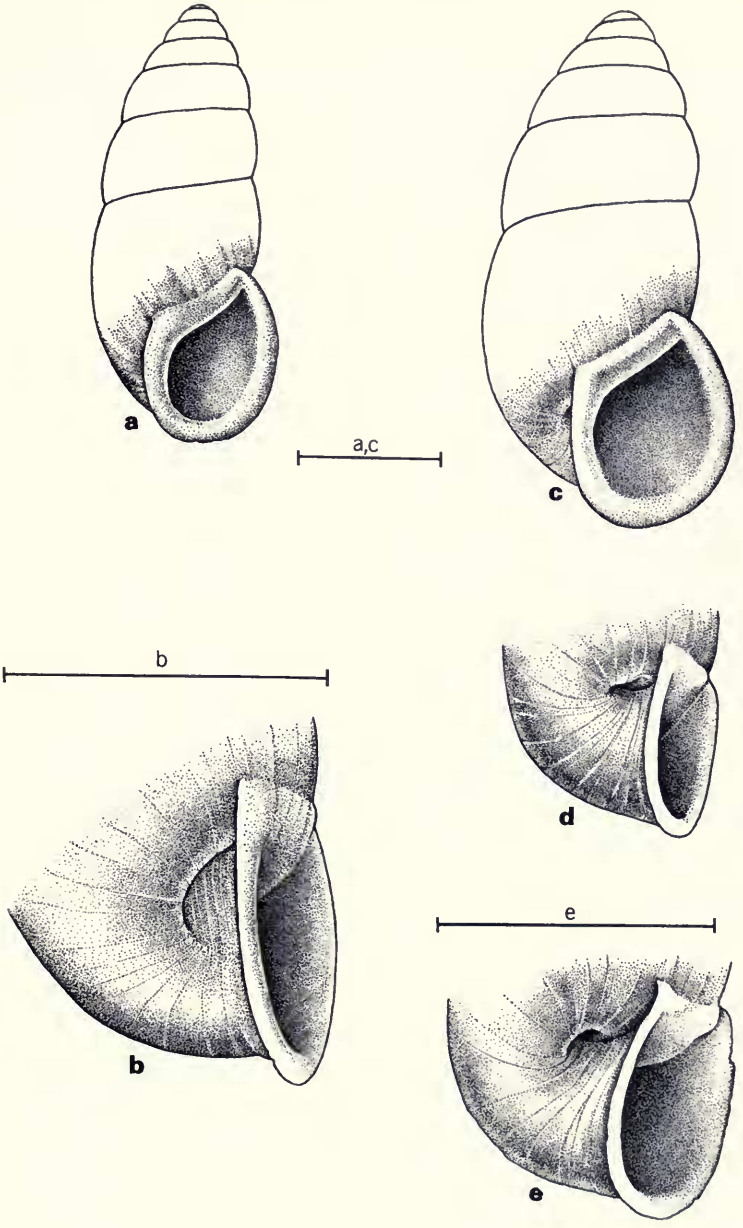

FIG. 9. **a-b**, *Subzebrinus tandjanensis* (Kobelt), South of Kunduz, Baqhlan Prov., Afghanistan, FMNH 147165; **c-d**, *Subzebrinus eremitus* (Benson), East of Maimana, Fariab Prov., Afghanistan, FMNH 147147; **e**, *Subzebrinus oxianus* (Martens), Turkestan, Paratype, FMNH 48251. Scale lines equal 5 mm.

Zoological Survey of India could not provide geographic coordinates. Although well known in the 1880's, today it seems unidentifiable.

The Afghanistan shells compare most closely to the description of *S. tandjanensis,* with the set from Faizabad (table IV) almost exactly equaling the cited size of the types. Shells from Kunduz are considerably larger in size, but agree in shape and sculpture with the Faizabad examples. Since chronologically separated sets of *S. eremitus* from the Aq Kupruk caves (see Solem, 1972) showed mean shell heights varying from 17.8 to 20.9 mm. (16.9 per cent), and altitudinally separated sets of *S. drangiana* varied by 24 per cent (calculated from data in Jaeckel, 1956, p. 345), the difference from 10.7 to 13.8 mm. (29.0 per cent) between the Faizabad and Kunduz sets does not seem excessive for specific grouping. Paratypes of *Subzebrinus oxianus* (Martens) from Turkestan (FMNH 48251) and sets of variety *schahrudensis* (Böttger) from Sejuch (FMNH 123649, FMNH 129606) and Kerman (FMNH 11829), Iran, were quite similar in sculpture and color, but had a much wider umbilical chink (fig. 9e) than the Afghanistan shells (fig. 9b). Starmühlner and Edlauer (1957, p. 468, pl. 2, fig. q) report *S. oxianus* var. *schahrudensis* from Badakhshan. I have not seen these specimens and cannot tell whether they are correctly identified or belong to this species. Likharev & Rammel'meier (1962, p. 219) synonymize *S. oxianus* with the Russian *S. sogdianus* (Martens, 1874) from the Tadzhik, Kirgiz, and Samarkand regions. No resolution of these different opinions is possible with currently available material.

Subzebrinus drangianus Jaeckel, 1956

Zebrina (Subzebrinus) drangiana Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 344-345, figs. 2, 3—Bashgul-Tal, Nuristan, Afghanistan at 1,100-1,500 m. elevation.

Remarks.—Although no material of this species was taken by the Street Expedition, raw data taken from Jaeckel (loc. cit.) is analyzed in Table III. The decreasing size correlated with increasing altitude is obvious and statistically significant. Interpretation of interpopulational variation in new material reported on at this time was greatly influenced by the results obtained by statistical analysis of Jaeckel's measurements.

Subzebrinus eremitus (Benson, 1849). Figure 9c,d.

Bulimus eremitus Benson, 1849, *in* Reeve, Conch. Icon., **5**, *Bulimus*, pl. 78, fig. 573—"march . . . from the Bolun (=Bolan) Pass to Cabul (=Kabul), Afghanistan."

Pupa spelaea Hutton, 1849, J. Asiatic Soc. Bengal, 18, p. 653—Dusht-i-Be-dowlut and Bolan Pass, Afghanistan.

Bulimus spelaeus (Hutton), Hutton, 1850, J. Asiatic Soc. Bengal, 18, p. 967—indicates possible synonymy with *Bulimus eremitus* Benson, 1849.

Buliminus eremita (Benson), Ancey, 1893, Bull. Soc. Zool. France, 18, p. 43—Dusht-i-bedoulet desert.

Buliminus (Subzebrinus) eremita (Benson), Kobelt, 1902, Syst. Conch. Cab., I, 13, (2), pp. 951-2, pl. 133, fig. 7.

Ena eremita (Reeve) (sic) Gude, 1914, Fauna British India, Mollusca, 2, pp. 247-248.

Zebrina (Subzebrinus) eremita (Reeve), Jaeckel, 1956, Mitt. Zool. Mus. Berlin, 32, (2), p. 342.

Subzebrinus eremita (Benson), Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, 42, p. 182—Kunduz, Jozjan and Fariab Provinces, Afghanistan; Solem, 1972, Trans. Amer. Philos. Soc., 62, (4), pp. 59-61.

Records.—Aq Kupruk caves, Balkh Prov. (989 specimens, many sets in FMNH); 25 miles east of Maimana, 1,220 m. elevation, in conglomerate on dry rocky hillside, Fariab Prov. (51 specimens, FMNH 147147-8).

Remarks.—Variation in the cave materials has been surveyed briefly by Solem (1972). Fluctuations in mean shell height between 17.8 and 20.9 mm. occurred over a 20,000-year period, probably indicating minor shifts in moisture supplies. The Maimana shells came from a dry gully and on a northeast-facing slope of 40°. Two vials of shells were catalogued separately. Size and shape variations in the two sets are summarized in Table IV. The difference in whorl count is not a measurement or computational error, since remea-

Table III. - Variation in Subzebrinus drangianus Jaeckel[1]

	NUMBER OF SPECIMENS	HEIGHT	DIAMETER	H/D RATIO
Bashgul-Tal at:				
1,100 meters	7	9.5±0.21 (9.0-10.3)	3.0±0.03 (2.9-3.1)	3.17±0.07 (3.00-3.52)
1,150 meters	2	9.7±0.30 (9.4-10.0)	3.1	3.13±0.10 (3.03-3.23)
1,200 meters	5	8.9±0.54 (7.8-10.5)	2.7±0.19 (2.0-3.1)	3.33±0.21 (2.83-3.90)
1,500 meters	5	7.7±0.17 (7.1-8.1)	2.7±0.07 (2.5-2.9)	2.82±0.07 (2.63-3.08)

1. Data from Jaeckel (1956, p. 345)

Table IV. - Variation in Zootecus and Afghanistan Enidae

	NUMBER OF SPECIMENS	HEIGHT	DIAMETER	H/D RATIO	WHORLS
Zootecus insularis chion					
FMNH 156598	45	11.8±0.15 (9.8-14.3)	5.66±0.071 (4.3-6.4)	2.09±0.024 (1.78-2.42)	7 3/4+(7 1/8-9)
Subzebrinus tandjanensis					
Kunduz FMNH 147165	4	13.8±0.46 (13.3-15.2)	6.52±0.19 (6.1-6.9)	2.13±0.076 (1.91-2.26)	6 3/4+(6 3/8-7)
Faizabad FMNH 147162	19	10.7±0.24 (8.8-12.9)	5.34±0.063 (4.8-5.75)	2.01±0.028 (1.81-2.28)	6 3/8-(5 7/8-6 7/8)
S. eremitus					
Maimana FMNH 147147	18	17.2±0.20 (15.2-18.7)	8.12±0.147 (6.6-9.1)	2.13±0.026 (1.91-2.39)	7 3/8-(6 7/8-8)
FMNH 147148	8	17.3±0.37 (13.9-19.1)	8.22±0.258 (6.6-9.2)	2.10±0.109 (1.95-2.30)	6 7/8(6 1/2-7 1/8)
Aq Kupruk Caves Many Sets	719	19.4±0.06 (15.3-23.7)	7.80±0.018 (6.9-9.1)	2.48±0.006 (1.99-3.08)	-------
S. coelocentrus					
Lectotype	1	28.0	10.3	2.72	8 1/4
var. minor	1	23.8	10.0	2.38	8 1/4
var. subovata	2	19.4 20.4	8.0 8.85	2.43 2.31	8- 7 7/8
var. austeniana	1	17.9	7.7	2.32	7 1/4
	NUMBER OF SPECIMENS	HEIGHT	DIAMETER	H/D RATIO	WHORLS
S. streeti					
FMNH 141173, FMNH 160024	2	26.1 (25.8-26.5)	13.3 (13.1-13.6)	1.96 (1.95-1.97)	7 3/8
S. griffithsii					
Chigha Sarai FMNH 147167	16	28.8±0.41 (25.7-31.0)	11.0±0.18 (9.8-12.6)	2.62±0.036 (2.41-2.92)	8 3/4(8 1/8-9 1/4)
Kandahar-Kuna[1]	9	25.9±0.77 (23.0-28.6)	8.42±0.188 (7.2-9.0)	3.07±0.062 (2.73-3.33)	-------
Bashgul-Tal[1]	17	25.4±0.74 (19.1-29.0)	8.31±0.196 (6.7-9.5)	3.05±0.146 (2.82-3.27)	-------

1. Data taken from Jaeckel (1956, page 343)

surement of the material produced the same results. Probably, they were picked up from a different part of the slope. Both sets are distinctly smaller than the Aq Kupruk shells.

Various Russian and Indian species can be compared with *S. eremitus,* but until their anatomy has been studied and ecological variation investigated, it will not be possible to suggest synonymy. None of the Iranian taxa (see Starmühlner and Edlauer, 1957) appear to be closely related.

Subzebrinus coelocentrus (Ancey, 1893). Figures 10, 11.

Buliminus coelocentrum Ancey, 1893, Bull. Soc. Zool. France, **18**, pp. 42, 43, 45-

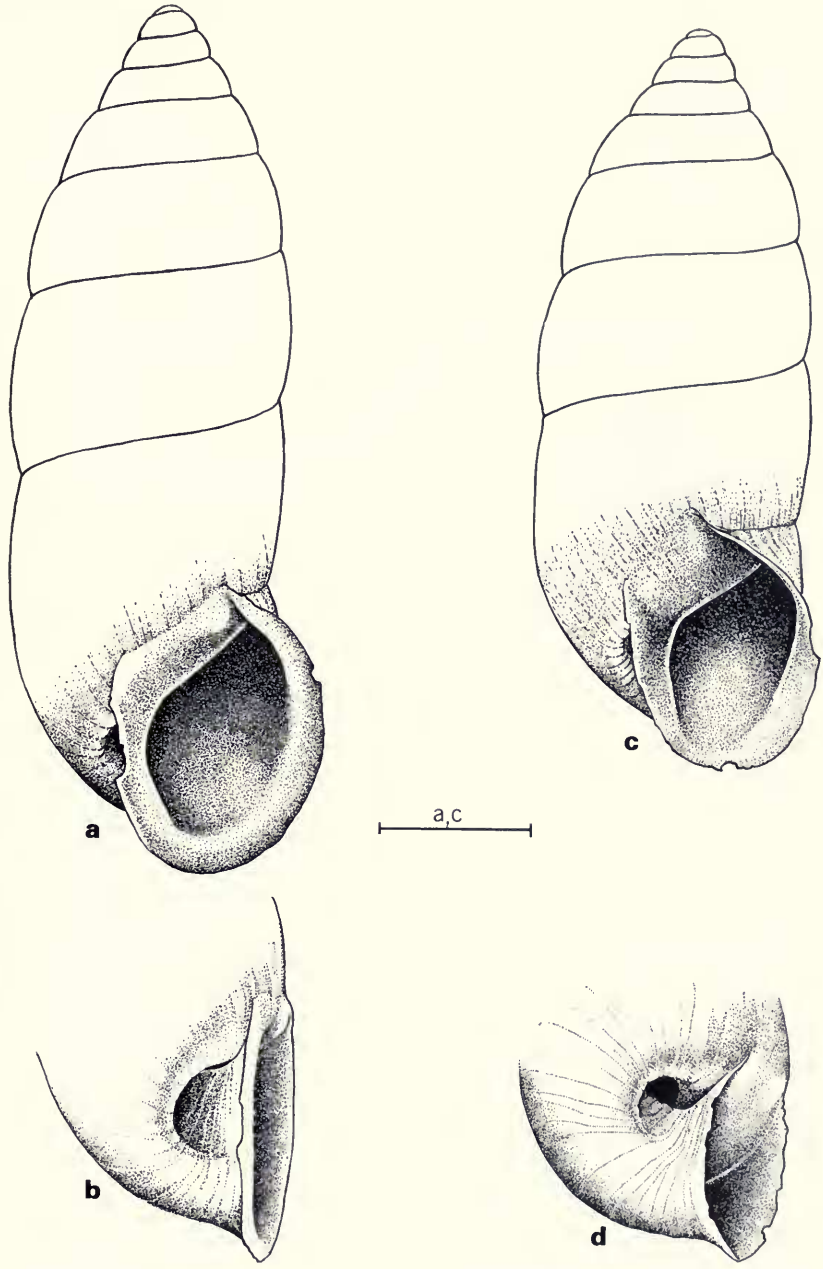

FIG. 10. **a-b**, *Subzebrinus coelocentrus* (Ancey), Lundi Katal Hills, Khyber Pass, Afghanistan, Holotype, NMW; **c-d**, *Subzebrinus coelocentrus* var. *minor* (Ancey), Lundi Katal Hills, 4,000 ft. elevation, Khyber Pass, Afghanistan, Lectotype, NMW. Scale line equals 5 mm.

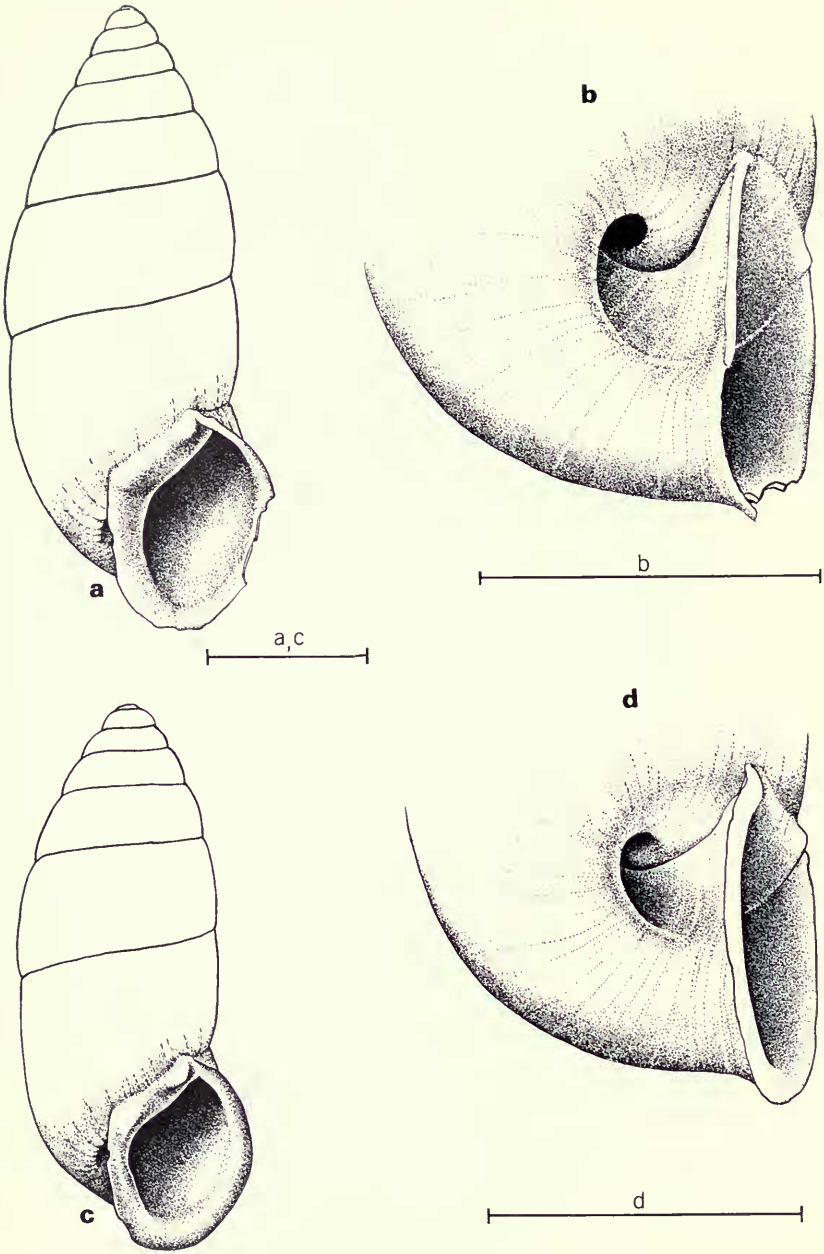

FIG. 11. **a-b**, *Subzebrinus coelocentrus* var. *subovata* (Ancey), Lundi Katal Hills, Khyber Pass, Afghanistan, Lectotype, NMW; **c-d**, *Subzebrinus coelocentrus* var. *austeniana* (Ancey), Lundi Katal Hills, Khyber Pass, Afghanistan, Lectotype, NMW. Scale lines equal 5 mm.

47—Lundi Katal Hills, near Khyber Pass, Afghanistan with varieties *minor, subovata,* and *austeniana.*

Buliminus (Subzebrinus) austenianus Ancey, Kobelt, 1902, Syst. Conch. Cab., I, 13, (2), p. 959.

Buliminus (Subzebrinus) coelocentrum Ancey, Kobelt, 1902, Syst. Conch. Cab., I, 13, (2), pp. 963-4.

Buliminus ? coelocentrum Ancey, Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 342.

Record.—Lundi Katal Hills near Khyber Pass (6 specimens, types of nominate form and varieties *minor, subovata, austeniana* in the National Museum of Wales, Cardiff).

Remarks.—Although very similar to *Subzebrinus eremitus* in size and general appearance, the much larger umbilical chink (figs. 10, 11) and more prominent bump at the parietal-palatal margin probably indicate that they are distinct on at least a subspecific level. Measurement of the type specimens are given in Table IV, and outline drawings of the shells, in Figures 10 and 11. The 56.4 per cent size difference between the type of variety *austeniana* and the nominate type, 17.9 to 28.0 mm. in height, is almost identical to the percentage spread (58.1 per cent) between the smallest (height 15.3 mm.) and largest (height 23.7 mm.) examples of *S. eremitus* from the Aq Kupruk cave deposits. Since the types of both *coelocentrus* and *minor* show repaired shell breaks, which frequently lead to distorted growth, the shape differences between the varieties may not be overly significant. Without population samples, judgements of their affinities will be impossible.

Subzebrinus streeti, new species. Figure 12c,d.

Diagnosis.—A large, relatively broad species with regularly tapering spire and a large umbilical chink. The comparatively low whorl count, 7⅜, and broad spire angle separate it from species of similar size found in Pakistan and Russia. *Subzebrinus potaninianus* (Ancey, 1886) variety *germabensis* (Böttger, 1889) is most similar in appearance, but has a narrower umbilicus and lower spire angle.

Description.—Shell large, with 7⅜ whorls. Spire increasing regularly until penultimate whorl, whose rate of widening is decreased, body whorl not constricted. Apical whorls 2¼, macroscopically without trace of sculpture. Lower whorls with irregular protractive growth wrinkles, occasional faint malleations at odd intervals, and microscopic traces of very fine, crowded, spiral grooving on smoother parts of shell surface. Color white, portions of spire with faint indications of hydrophanous markings. Aperture elongately ovate, columellar wall almost straight with a nearly right angle at basal margin. Columellar lip thickened, straight, broadly extended outward, basal and lower palatal lips moderately flared, upper palatal lip gradually less flared, until at junction with parietal wall, it is barely expanded. Parietal callus weak over most of surface, built up into a heavy ridge just before columellar lip and with a

subnodular swelling just below parietal-palatal margin. Umbilical chink (fig. 12d) wide and prominent, sharply narrowing internally. Height of holotype 26.5 mm., diameter 13.6 mm., H/D ratio 1.95.

Holotype.—Afghanistan: a few miles north of Chigha Sarai, dry stream bed, 823 m. elevation, southern Nuristan, Konar Prov. (ca. 34° 52′ N, 71° 10′ E). Collected by Janet K. Street on October 12, 1965. FMNH 160024.

Paratypes.—Jalalabad, 732 m. elevation, Nangarhar Prov. (1 specimen, FMNH 147173); north-facing slope, 7 miles west of Jalalabad, 793 m. elevation, Nangarhar Prov. (1 specimen, FMNH 147171).

Remarks.—Two adults and a single juvenile specimen were available. Although some hesitation was felt in describing a new species in such a variable group from limited material, comparisons with taxa from neighboring areas left no alternative. There was either an obvious 50 per cent or more size and shape difference, or comparisons showed distinctions in form and umbilical contour that negated probable affinity. The adult paratype has the lip less reflected and the umbilical chink smaller than in the holotype. This may be an age factor, with the paratype slightly subadult and the columellar lip and, hence the umbilical chink, less fully developed.

The most similar appearing species is *Subzebrinus potaninianus* (Ancey, 1886) variety *germabensis* (Böttger, 1889) described from Germab in the Kopet Dag region along the Iranian-Soviet Union border. In older collections, this is considered a form of *S. eremita* and has been reported so far east as "Boei, West Szechuan, China" (FMNH 76732 ex Laidlaw, Stoetzner Expedition). Probable type lot material (FMNH 48026 ex W. F. Webb) is slenderer than those figured by Matekin (1959, figs. 4, 33), agreeing better with Matekin's Figure 28. The material described here differs consistently in its much larger umbilicus and greater spire angle. Although approaching the shape of some *Pupinidius* and *Petraeomastus* (see Yen, 1939, pl. 7, figs. 45-52, pl. 8, figs. 1-5), the apertural form and umbilicus relate this to *Subzebrinus*. Of the Indian species, the problematic *Bulimus eous* Reeve, 1850, whose type is lost and whose identity is unknown, apparently is similar in size, but has a quite different spire, if the spire was not deformed. This name cannot be utilized. *Subzebrinus candelaris* (Pfeiffer, 1846) is much more slender and usually sinistral; *S. domina* (Benson, 1857), *S. longstaffi*

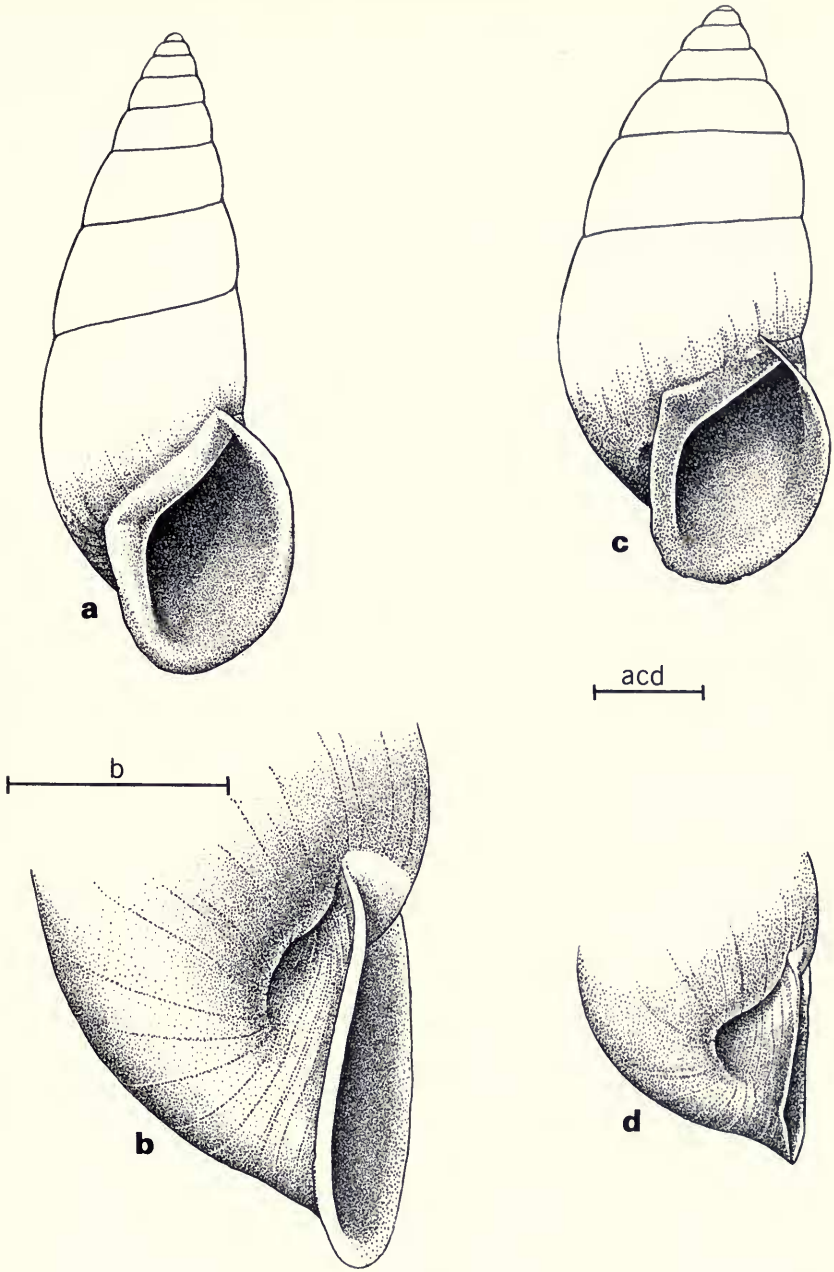

FIG. 12. **a-b**, *Subzebrinus griffithsii* (Benson), Chigha Sarai, Southern Nuristan, Afghanistan, FMNH 147167; **c-d**, *Subzebrinus streeti,* new species, Chigha Sarai, Southern Nuristan, Afghanistan, Holotype, FMNH 160024. Scale lines equal 5 mm.

Gude, 1914, and *S. griffithsii* (Reeve, 1848) all have more whorls, a narrower umbilicus, and are slenderer shells. They are the nearest relatives.

Great pleasure is taken in dedicating this species to the William S. Streets in token appreciation for their efforts in accumulating this material.

Subzebrinus griffithsii (Benson, 1848). Figure 12a,b.

Bulimus griffithsii Benson, 1848, *in* Reeve's Conch. Icon., **5**, *Bulimus,* pl. 47, fig. 302—Afghanistan.

Bulimus griffithii (sic) Benson, Pfeiffer, 1853, Syst. Conch. Cab., I, **13**, p. 72, pl. 20, figs. 15, 16.

Subzebrinus griffithi (sic) (Reeve) f. *minor,* Hesse, 1933, Arch. Naturgesch., N.F., **2**, (2), pp. 213-214, fig. 39 (anatomy)—Flusse Porun, Afghanistan; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, pp. 181-182.

Zebrina (Subzebrinus) griffithii (sic) (Reeve), Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), pp. 342-343, fig. 1 (anatomy)—Kandahar-Kuna and Bashgul-Tal, Afghanistan.

Record.—Dry stream bed, Chigha Sarai, 823 m. elevation, Southern Nuristan, Konar Prov. (18 specimens, FMNH 147167).

Remarks.—One living specimen was not recognized as such in the field and dried up during transit to Chicago. Since both Hesse (loc. cit.) and Jaeckel (loc. cit.) figured the terminal genitalia, generic placement of this species was not in doubt.

Variation in the two populations studied by Jaeckel (1956) is summarized in Table IV, together with measurements of the Chigha Sarai set. The latter specimens are slightly larger in size, but whether the recorded difference in H/D ratio is the result of altered measuring technique or an actual change in shape is unknown.

The very much larger size, tapered spire, and strongly flaring lip immediately separate *S. griffithsii* from other species covered in this paper. *Subzebrinus candelaris* (Pfeiffer, 1846), reported from the Afghanistan-Pakistan border area, is even larger and normally sinistral.

Order Sigmurethra
Suborder Aulacopoda
Superfamily Succineacea
Family Succineidae

Jaeckel (1956, pp. 340-341) listed three Palearctic and one Indian species of succineid as living in Afghanistan. Likharev &

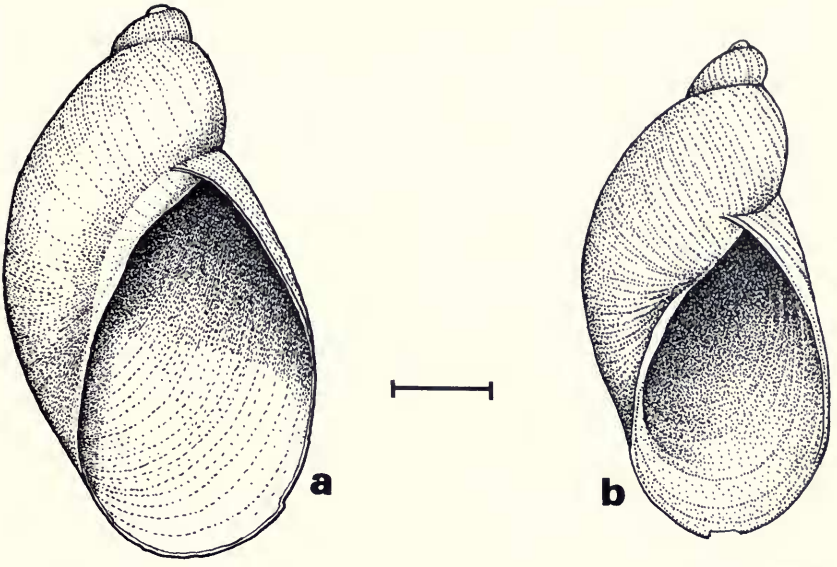

FIG. 13. a, *Oxyloma indica* (Pfeiffer), Baniyan, Baniyan Prov., Afghanistan, FMNH 147136; b, *Oxyloma pfeifferi* (Rossmässler), Girishk, Helmand Prov., Afghanistan, FMNH 147159. Scale line equals 2 mm.

Starobogatov (1967, p. 179) listed two Palearctic species. Since these records were based on shell material only, confirmation through dissections will be required. Two species were represented in the Street material. Although they are tentatively referred to known species, more extensive studies of European and Indian species may require that they be named. I prefer not to do so at this time.

Oxyloma indica (Pfeiffer, 1849). Figures 13a; 14.

Succinea indica Pfeiffer, 1849, Proc. Zool. Soc. London, **1849**, p. 133—Bleensal (=Bhim Tal), Kumaon Dist.; Gude, 1914, Fauna of British India, Mollusca, **3**, pp. 447-448; Rao, 1924, Rec. Indian Museum, **26**, (5), pp. 378-382, fig. 9C, D (p. 400), pl. 28, figs. 4-9.

Records.—Herat, 915 m. elevation, Herat Prov. (2 specimens, FMNH 147153); 29 km. southwest of Eshkershem, 2,653 m. elevation, Badakshan Prov. (17 specimens, FMNH 147132); along stream in cultivated valley, Bamiyan, 2,800 m. elevation, Bamiyan Prov. (22 specimens, FMNH 147136, FMNH 147141).

Remarks.—The shorter spire and broader apical whorls of these shells (fig. 13a) combine with a reduced whorl count to separate them from European specimens of *Oxyloma pfeifferi*. On the basis of

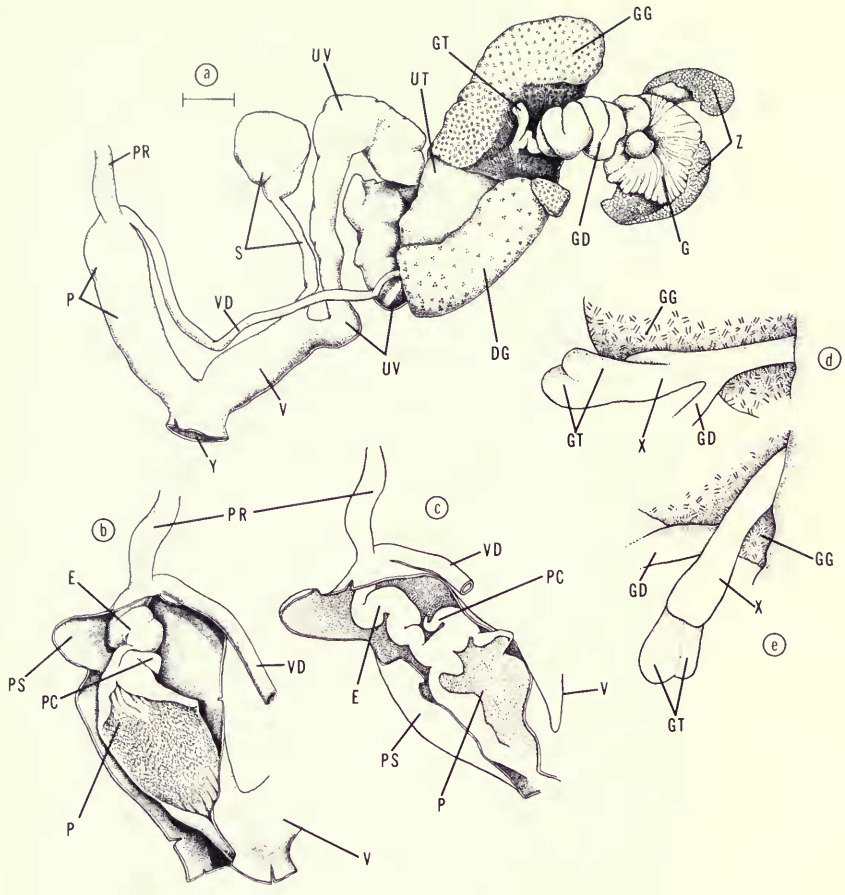

FIG. 14. Anatomy of *Oxyloma indica* (Pfeiffer), Bamiyan, 2,800 m. elevation, Bamiyan Prov., FMNH 147136: **a**, entire genitalia expanded to show origins and insertions; **b-c**, view of penis interior to show normal position (*b*) and size of both epiphallus (E) and penial caecum (PC) (*c*); **d-e**, gross appearance of talon (GT) and carrefour (X). Scale line equals 5 mm., *b-e* greatly enlarged.

genital anatomy (fig. 14a), this material has a proportionately much larger and longer prostate (DG), a bi-folded free oviduct (UV), a shorter spermatheca (S), a longer vagina (V), and a much less clearly divided talon (fig. 14d,e, GT) than do the British examples of *O. pfeifferi* (see Quick, 1933, pl. 23, figs. I-K). Rao (1924, p. 400, fig. 9C, D) figured the genitalia of Indian material to which he referred as *O. indica,* although the dissected material was not from the type locality. Possibly, the vagina (erroneously labeled "ut." by Rao) is

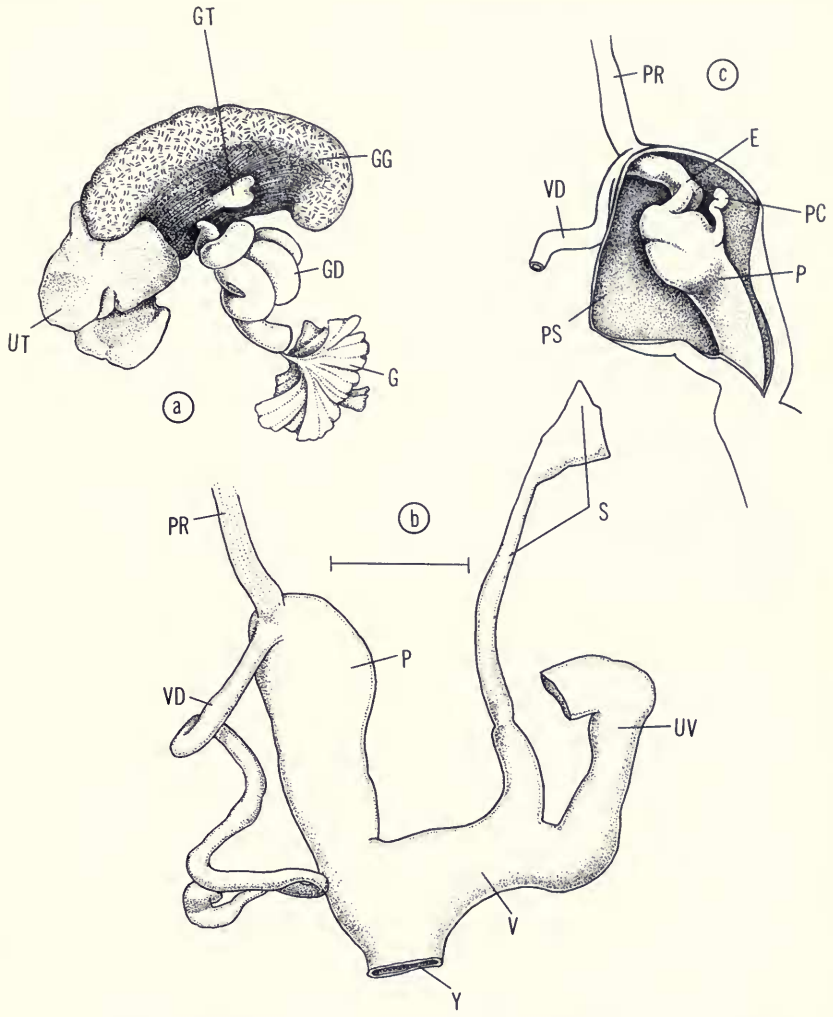

FIG. 15. Terminal genitalia of *Oxyloma pfeifferi* (Rossmässler), Girishk, Helman Prov., FMNH 147159: **a**, detail of apical genitalia, ovotestis mostly removed; **b**, terminal genitalia; **c**, interior of penis showing very long penial caecum (PC). Scale line equals 2 mm., *a* and *c* greatly enlarged.

slightly shorter than that in the Afghanistan specimens, but otherwise there is agreement as to structural details.

Figures of the entire genitalia and details of the talon and penial interior are presented here, but only partial description of the anatomy.

Oxyloma pfeifferi (Rossmässler, 1835). Figures 13b; 15.

Succinea pfeifferi Rossmässler, 1835, Iconographie Land- und Süsswasser-Mollusken, **1**, (1), p. 92, fig. 46; Quick, 1933, Proc. Malacol. Soc. London, **20**, (6), pp. 302-305, figs. 1, 7, 10-17, pl. 23, figs. I-K, M-O, pl. 25, figs. 3-5.

Record.—Girishk, 945 m. elevation, Helmand Prov. (1 specimen, FMNH 147159).

Remarks.—The shell (fig. 13b) falls within the range of variation illustrated by Quick (1933, pl. 25, fig. 3), but the genitalia (fig. 15a-c) do not correspond exactly. The vagina (V) is distinctly shorter, and the prostate (not shown) is apparently longer, the talon (GT) is shorter, and the penial caecum (PC) is much larger than in any of the British species figured by Quick and distinctly longer than in *O. indica* (fig. 14a). The longer vagina of *O. indica* also serves to separate the two Afghanistan species.

Although a case could be made for granting nomenclatural separation from *O. pfeifferi,* the addition of another potential synonym to the literature on succineids cannot be defended. I prefer to indicate its strong similarities to the Eurasian species by retaining that name.

The status of the name itself is uncertain. Waldén (1976, p. 24) pointed out that there has been lengthy confusion of the names *elegans* Risso, 1826, *pfeifferi* Rossmässler, 1835, and *sarsi* Esmark, 1886. Zilch (1978, p. 122, pl. 8, fig. 16) figured the lectotype of *pfeifferi* and synonymized it with *elegans.* Since the *elegans* of Quick (1933) is actually *O. sarsi, O. elegans* is what Quick (1933) called *O. pfeifferi,* and the Afghanistan specimens are of uncertain specific relationship, the use of an approximate name seems the best temporary solution.

Superfamily Limacacea
Family Zonitidae

Phenacolimax (Oligolimax) conoidea (Martens, 1874)

Vitrina conoidea Martens, 1874, Sliznyaki (Mollusca) *in* Fedtschenko's Puteshestvie V Turkestan, **2**, part 1, no. 1, p. 8, pl. 1, fig. 5—Sarafschan.

?Helicolimax annularis (Studer), Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 346—Walang, Salang-Tal, Hindu Kush, and Ghorband-Tal, Afghanistan; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 186—Kabul, Badakhshan, Fariab, and Herat Provinces, Afghanistan.

Helicolimax (Oligolimax) annularis var. *conoidea* (Martens), Likharev & Rammel'meier, 1962, Keys to the Fauna of the U.S.S.R. (English translation), **43**, pp. 338-339.

Phenacolimax (Oligolimax) conoidea (Martens), Solem, 1972, Trans. Amer. Philos. Soc., **62**, (4), p. 61.

Record.—Aq Kupruk Cave deposits, Balkh Prov. (1 specimen, FMNH 157175).

Remarks.—Discovery of this fragile shell in the cave deposits was surprising. I have used the name *conoidea* for this specimen, since it agrees in shape and apical sculpture with specimens from Samarkand (FMNH 44512, FMNH 125535) identified as *P. conoidea*, rather than with European examples identified as *P. annularis* (Studer) (FMNH 10987, FMNH 103423-4). The latter are much lower spired and have finer sculpture. The affinities of the two taxa are very uncertain.

Phenacolimax is immediately distinguished from any other Afghanistan snail by its widely flaring aperture, closed umbilicus, raised spire with only four whorls, and very thin, shining shell. *Syama* and *Zonitoides* are flat spired or only moderately elevated and have much thicker shells with more whorls and narrower apertures.

Zonitoides (Z.) nitidus (Müller, 1774)

Helix nitida Müller, 1774, Verm. terr. et fluv. hist., **2** p. 32—Fridrichsberg, Denmark.

Zonitoides nitidus (Müller), Pilsbry, 1948, Land Mollusca of North America, **2**, (2), pp. 476-480, figs. 259, 260; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 185—Bamitan, Badakhshan, Jozjan, and Fariab Provinces, Afghanistan.

Record.—Found in a mammal burrow, Maimana, 884 m. elevation, Fariab Prov. (1 specimen, FMNH 147145).

Remarks.—A subadult example of this common Palearctic species was taken in a mammal burrow. It was not recorded from Iran by Forcart (1935), Biggs (1937), Starmühlner & Edlauer (1957), or Starmühlner (1965). Likharev & Rammel'meier (1962, p. 327) stated that it ranges "south to Samarkand." Likharev & Starobogatov (1967) reported material from several provinces in northern Afghanistan.

Family Parmacellidae
Genus *Parmacella* Cuvier, 1805
Subgenus *Proparmacella* Simroth, 1912

Although Godwin-Austen (1882-1889, p. 217) indicated his inten-

tion in 1888 to describe a new genus, *Candaharia*, for the species discussed below, it was not until much later (1914) that a formal description of *Kandaharia* was presented (Godwin-Austen, 1889-1914, pp. 314-316). In the meantime, Simroth (1912, p. 43) had proposed the subgenus *Proparmacella* for *Parmacella kainarensis*, a new species from Kainar in Buchara, southwest of Samarkand. Likharev & Starobogatov (1967, p. 187) synonymized the two after dissecting Afghanistan examples. Zilch (1959-1960, p. 264) has accepted *Candaharia* Godwin-Austen, 1888 as a *nomen nudum*. Although its "description" is equivalent to most Iredalean genera, consideration as a *nomen nudum* is desirable.

Previous dissections of *Parmacella* have concentrated on the gross genital structures and pattern of digestive looping, although Simroth (1883, pl. 1, figs. 7, 11) has figured the pallial region and functioning surfaces of the terminal genitalia for *Parmacella olivieri ibera* Eichwald. This species shows numerous differences from both *P. rutellum* and *P. olivieri* Cuvier as figured by Forcart (1959, fig. 2). Opportunity is taken to present topographic illustrations of the overall anatomy and to investigate functioning surfaces of the terminal genitalia. No detailed description of the organ systems is attempted, but the basic method of accommodation to visceral hump reduction is outlined for ease in comparisons with other slug taxa.

The visceral hump remnant is located distinctly behind the body midpoint, with the anterior margin of the mantle lobe averaging 35.8 per cent of the distance from snout to tail. The coiled, strongly calcified embryonic shell (fig. 19f, g) protrudes posteriorly (figs. 16a; 17a, b) from the very thick shell lap (L). Anterior of the embryonic portion, the shell (fig. 17b) consists of at first a broad and weakly calcified plate that soon is reduced to a periostracal remnant extending forward to the mantle margin between shell lap (L) and mantle lobe (ML). A high, ridged pocket (fig. 17a) is formed by the sharply keeled tail which cups the protruding embryonic shell and posterior visceral hump margin.

Internally (fig. 17c), the visceral hump is highly reduced and compacted. The anus, external ureteric pore, and breathing pore share a common opening (LP). Pneumostome with a circular sphincter muscle outside level of anus and external ureteric pore, plus a narrower and thinner inner muscle ring. Hindgut passing to upper posterior margin of pneumostome, anal opening even with posterior margin and very slightly behind and below ureteric pore. Latter on posterior third of upper pneumostomal margin, an ovate papilla on its lower

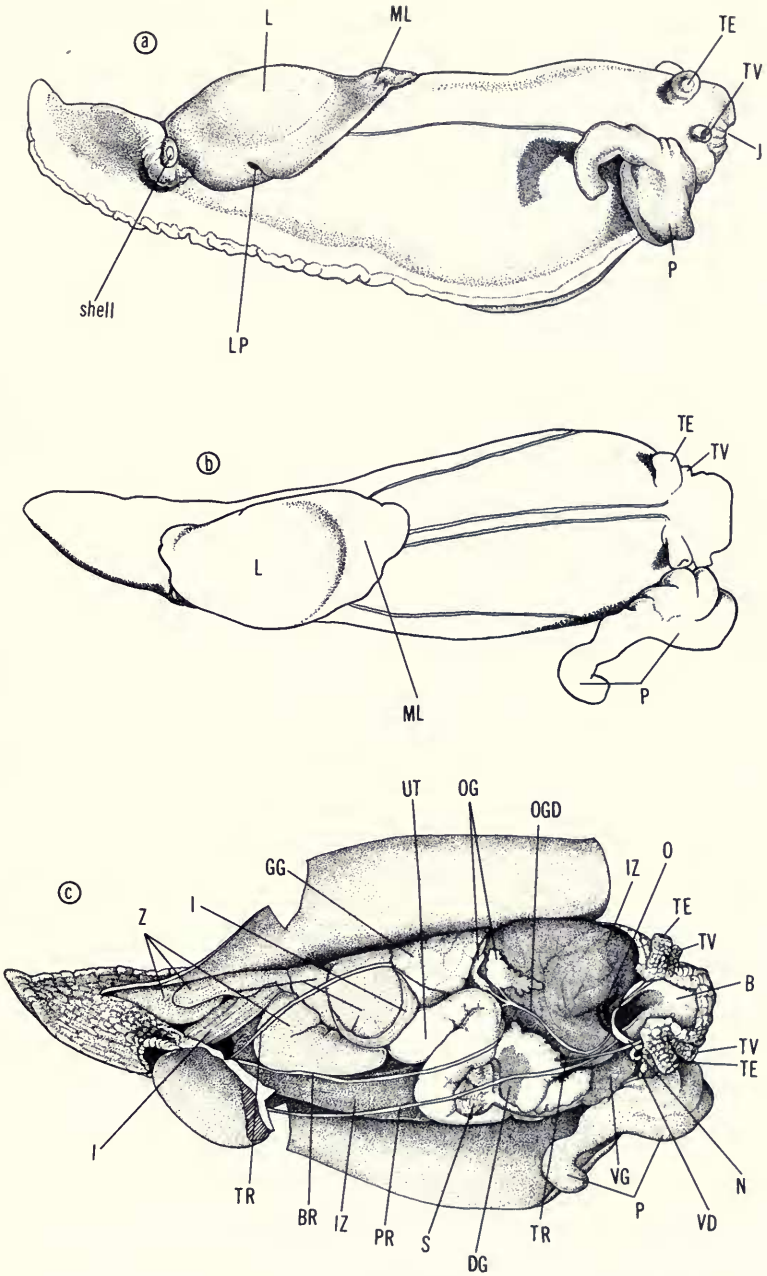

FIG. 16. *Parmacella rutellum* Hutton, Paghman, 2,440 m. elevation, Kabul Prov., Afghanistan, FMNH 147080: **a**, lateral view of specimen 45 mm. long with penis everted; **b**, dorsal view of same individual (note medial and lateral grooves on head and neck); **c**, dorsal topography of viscera with pallial region pulled aside, skin turned back, and diaphragm tissue removed.

margin providing closure of the secondary ureter. Margin between shell lap (L) and mantle lobe (ML) forming a channel from pneumostome (LP) to side of body for waste product flow (fig. 16a). Remnant of the free muscle system still attached to the calcified embryonic shell, with a very short columellar retractor (CR) splitting almost immediately into tentacular (TR) and buccal retractor (BR) components. The last intestinal loop, abruptly narrowing and sharply reflexing, enters through the posterior lower right-hand margin of the visceral hump, then reflexes forward as the hindgut (HG) to the anus. Posterior half of kidney (fig. 17c) high and visible in ventral view, anterior half narrowing abruptly as it passes above pericardial cavity. Secondary ureter rising above heart, near anterior margin of kidney, passing along inner kidney margin posteriorly to end of pallial cavity, sinuately reflexing and running anteriorly along side of hindgut to upper margin of pneumostome. Pericardium situated transversely below anterior portion of kidney, quite deep, relatively short laterally, with the auricle (HA) and ventricle (HP) characteristically having a "V"-shaped relationship. Aorta (HH) exiting almost vertically from pericardium. Principal pulmonary vein (HV) from right margin of pericardium, entering a bulbous, multichambered, sac-like structure that recalls the "lung" system in an Athoracophorid slug. Remaining surface of lung highly vascularized. Coiled embryonic shell remnant containing a single narrow protrusion of liver tissue, with no trace of genital structures remaining in pallial region.

Body cavity extending slightly posterior of visceral hump, in a lateral narrow slit on left side of body, its termination approximately halfway between tail tip and high ridge that cups the embryonic shell. Overall topographic displays of body cavity organs shown in Figures 16c and 17d. Digestive and genital system reduced to thin remnants.

Buccal mass (fig. 16c, B) short and compact, with esophagus (O) arising from midpoint, passing through nerve ring (N) and reflexing

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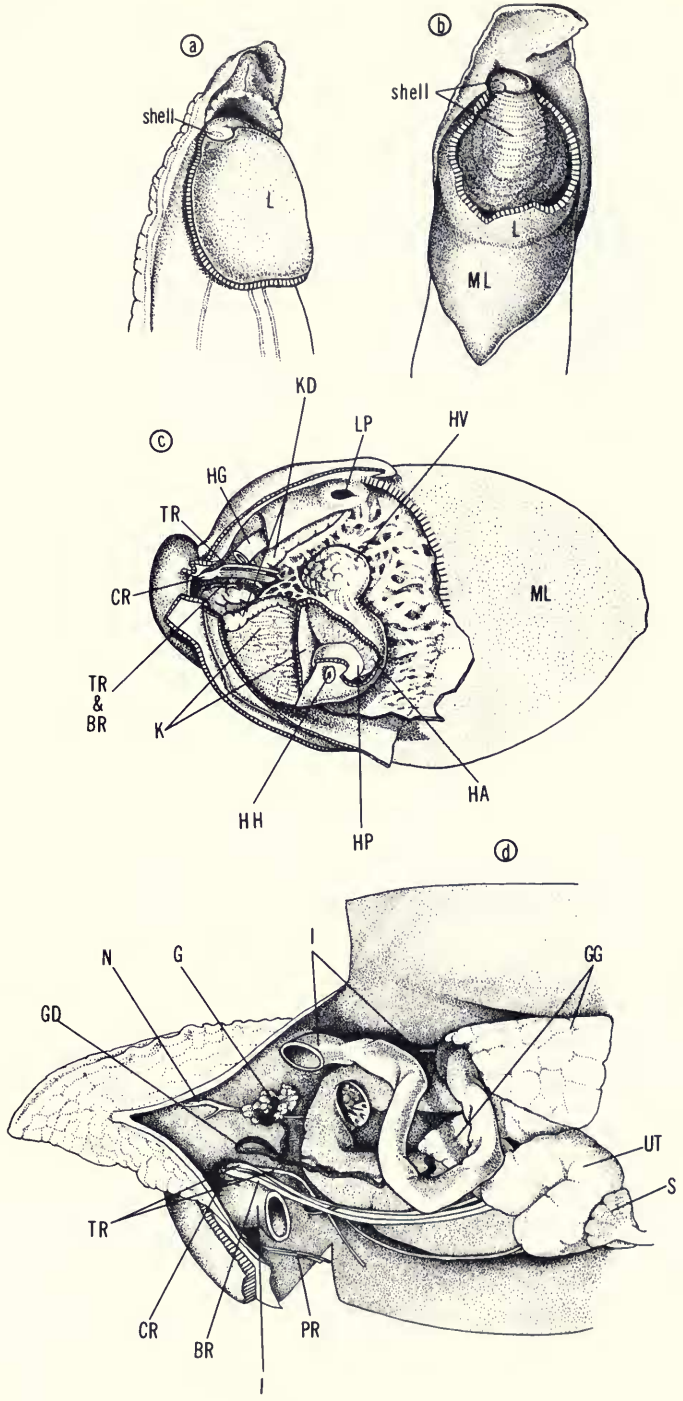
Opposite:

FIG. 17. *Parmacella rutellum* Hutton, Paghman, 2,440 m. elevation, Kabul Prov., Afghanistan, FMNH 147080: **a**, exterior of visceral hump with mantle lobe trimmed off; **b**, visceral hump with shell lap (L) partly removed showing pattern of shell remnant growth; **c**, ventral view of pallial complex with diaphragm removed; **d**, topography of posterior viscera with liver tissue removed to show loops of intestine and apical genitalia.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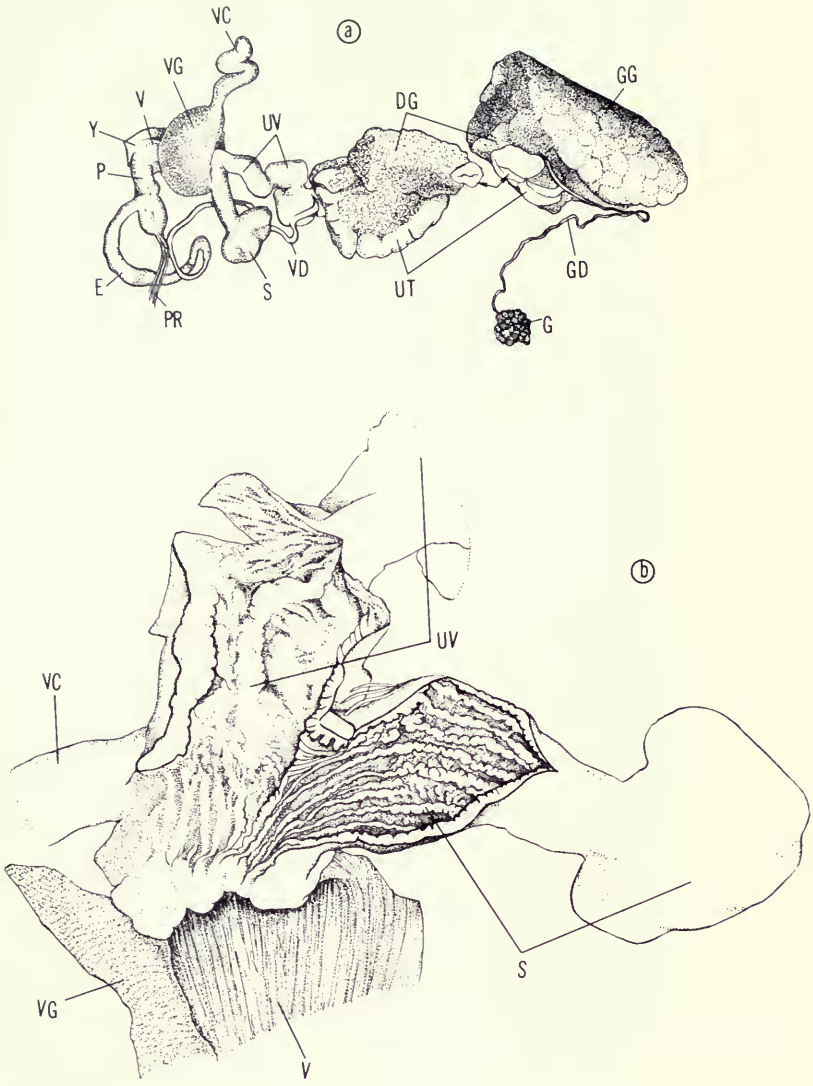

FIG. 18. *Parmacella rutellum* Hutton, Paghman, 2,440 m. elevation, Kabul Prov., Afghanistan, FMNH 147080: **a**, genitalia stretched out to show origins and insertions; **b**, functioning surfaces of terminal female genitalia.

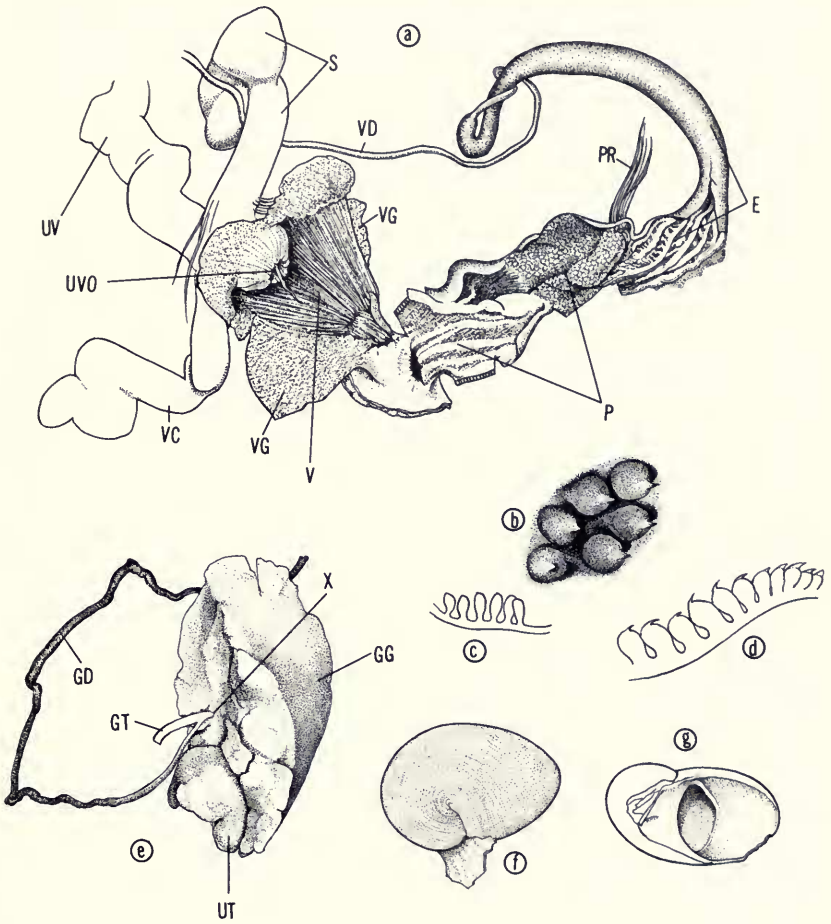

FIG. 19. *Parmacella rutellum* Hutton, Paghman, 2,440 m. elevation, Kabul Prov., Afghanistan, FMNH 147080: **a**, functioning surfaces of vagina (V) and terminal male genitalia; **b-d**, details of papillae found on apical portion of penis; **e**, union of hermaphroditic duct (GD) and talon (GT); **f-g**, embryonic shell in dorsal (*f*) and lateral (*g*) aspects. Scale line equals 1 mm.

to left side for very short distance before entering stomach (IZ). Salivary glands (OG) three, lying near left posterior margin of initial stomach cavity, two of these shown in Figure 16c, the third lying under the second curve of the uterus (UT). Anterior portion of stomach greatly swollen in all dissected material due to recent ingestion of plant leaf and stalk fragments. The bulging appearance of

the anterior half of the animal in Figure 16a and b is due entirely to stomach swelling. Initial bulge of stomach occupying center and left portion of body cavity back to base of albumen gland (GG). At this point, the stomach narrows and passes transversely to right ventral margin of body cavity, then continues directly posteriorly to the middle of visceral hump and reflexes over to left margin of body cavity, at which point it receives the liver ducts and then reflexes forward as intestine. Loops of intestine (I), somewhat complicated in outline, shown from two different aspects in Figures 16c and 17d. Initial forward run of intestine from stomach-bile duct junction along left ventral margin to apex of albumen gland. Intestine then travels vertically upward to top margin of albumen gland, reflexes across dorsal surface of body cavity to midline and just anterior to margin of digestive gland. At the end of this traverse, it touches part of the uterus, then continues its curve downward between lobes of the digestive gland, almost touching upper side of the intestinal loop before continuing slightly posterior of stomach reflexion, finally angling posteriorly to lower margin of visceral hump remnant, where it narrows and then reflexes forward as hindgut. Figure 17d shows the basic intestinal looping, with all digestive gland material removed and the last turn of intestine severed to enable demonstration of ovotestis position. Digestive glands (Z) multilobed, extending posteriorly to apex of body cavity, mostly lying on left side of body midline, anteriorly reaching to apex of albumen gland.

Ovotestis (G), a small clump of relatively distinct ovate follicles, lying on ventral margin of body cavity below about midpoint of visceral hump. Hermaphroditic duct (GD) highly kinked and coiled, passing above last loop of stomach, but below traverse of intestine to hindgut, passing forward to lower margin of albumen gland, entering into albumen gland surface. Talon (fig. 19e, GT), a slender, finger-like, tapered tube that is buried between folds of the albumen gland. Greatly narrowed tube of hermaphroditic duct entering laterally into talon just above its union with carrefour. Albumen gland (GG) very large, "U"-shaped, lying above stomach on left margin of body cavity, extending from dorsal margin down to ventral margin with a slightly more apical ventral extension almost to midline of animal. Details of carrefour and prostate-uterus junction not worked out. Prostate (DG) a yellow-orange mass of very finely granular tissue fastened in a broad band on the uterine surface. For most of length prostate mass lying morphologically beneath uterine folds. Uterus (UT) folded into three loops, that gradually move from

mid-dorsal line to lower right margin, surface with only minor indentations. Internally, uterus with large lumen that shows no obvious differentiation along points where prostate tissue attaches. A relatively short and narrow free oviduct (UV) forms a twisted and compactly tapering tube leading from base of prostate-uterus to junction with spermatheca. Inner walls of free oviduct (fig. 18b) containing very high and rugose longitudinal pilasters. Head of spermatheca (fig. 16c, S) lying between two lower loops of prostate-uterus, on dorsal surface of same, with penial retractor muscle (PR) running generally above the head. Shaft of spermatheca less than twice as long as head, relatively broad, internally with numerous narrow and corrugated pilasters (fig. 18b). Vagina (V) surrounded by a large mass of glandular tissue with a finger-like, partly coiled, caecum protruding from the glandular mass. Internally (figs. 18b; 19a) with relatively diverse structure. Caecum (fig. 18b, VC) without tubular opening to vagina lumen, upper region with numerous thin and high longitudinal pilasters, opening through a puckered pore into main chamber, whose walls (fig. 19a, V) are longitudinally striated and muscular. Glandular mass (VG) completely surrounding vagina without any single or collecting ducts into lumen of vagina. Latter opening at angle into very short atrium (Y), which is not morphologically differentiated from end of penis (P).

Vas deferens (VD) a very narrow tube from end of prostate, loosely bound to peni-oviducal angle, not attached to side of penis, gradually expanding to enter tapered head of epiphallus (fig 18a, E). Penial retractor muscle (figs. 17d; 19a, PR) arising from diaphragm near anterior margin of pallial cavity, lying on dorsal margin of body cavity until its insertion on head of penis (fig. 19a, P). Epiphallus (fig. 19a, E) more than 50 per cent longer than penis, internally with corrugated pilasters very similar to those found in the spermathecal stalk, opening into head of penis through a simple pore that is lateral to the penial retractor insertion. Penis (fig. 19a, P) a short tube, without significant external surface detail. Internally tri-zoned, apical portion with walls densely papillate, each papilla (fig. 19b-d) narrower basally than apically, surmounted by a short and recurved, apparently calcareous hook. Middle zone of penis (fig. 19a) with weak longitudinal muscular striations, very similar to those found in the vaginal lumen. Lower portion of penis with high, tapering, uncorrugated pilasters, fading out at edge of atrium. External gonopore single, but vagina and penis opening almost directly into pore, with a distinct atrial zone.

Embryonic shell (fig. 19f, g) consisting of a normal coiled first whorl, one resting place visible internally, followed by an immediate change to flat and plate-like growth. Fossil examples from the Aq Kupruk caves consist of either the embryonic fragment or the early embryo plus a small to extensive portion of the later plate-like growth. Quick checks of the fossil material showed that none of the nine intact embryonic shells showed any trace of the resting period illustrated in Figure 19g. Whether this is characteristic of forms collected under irrigated conditions or an accident is unknown.

In its basic pattern of adaptation to the slug form, *Parmacella* shows several unusual changes. The retention of a minute, coiled embryonic shell, with its single remnant of digestive gland, does not correlate well with the shift of digestive tissue into the left posterior portion of the body cavity where it is well removed and posterior to the visceral hump termination. This essential removal of the digestive tissue and intestinal loops from posterior intrusion onto the pallial cavity has enabled extreme compaction and shortening of the pallial region. As shown in Figure 17c, a typically sigmurethrous kidney and ureter relationship is maintained. The heart, however, lies transversely across the body axis and underneath the anterior portion of the kidney, which is deeply dished in order to accommodate the mass of heart tissue. Correspondingly, the posterior portion of the kidney is extraordinarily thick and elevated. With the shortening of the pallial region, area for lung venation is drastically reduced. The entire pallial roof region is heavily vascularized, particularly at the point where the principal pulmonary vein originates. A bulge of lung tissue in this region shows marked similarity in growth sense to the structures found in the tracheopulmonate slug groups.

Relative positions and sizes of both the genitalia and digestive organs have been altered drastically. Expansion of the esophageal tract just posterior of the buccal mass into a functioning stomach which then runs posteriorly and reflexes before the anterior margin of the visceral hump is relatively unusual. Intestinal looping, at its anteriormost point, is slightly shifted in relative position. Instead of the intestinal loops facing the sides of the albumen gland, they cross its apical margin before reflexing posteriorly. In position, the albumen gland and intestinal loop lie well in front of the pallial cavity. In general, the stomach occupies the left anterior, both dorsal and

ventral surfaces, and the right posterior ventral portion of the previsceral-hump body cavity. In contrast, the genitalia are compressed into the right central and left posterior portions of this region. In order to accomplish this, there is marked zonal compaction of the prostate-uterus by heavy sinuation of the organ, plus apparent foreshortening of the terminal genitalia, both male and female. In the dissected example, the relationships are somewhat altered by the fact of nearly complete penial eversion during the drowning process.

I do not have sufficient familiarity with the topographic anatomy of European and Middle Eastern taxa to attempt assessment of the origin for the Parmacellidae. On the basis of the structures delineated above, I have no hesitation in stating that they bear no close relationship to the larger zonitoid taxa of the Oriental region. I also agree with Forcart (1959, pp. 43-44) that *Parmacella* must be considered as distinct from the Limacidae.

Comparisons with the structures in Thailand helicarionid slugs, for example *Muangnua* and *Austenia* (see Solem, 1966, pp. 65-76, 84-93), show that the latter have used an entirely different strategy in visceral hump organ accommodation. From 50-65 per cent of the visceral hump remnant contains reproductive and digestive tissue, whereas in *Parmacella*, only a single lobe of digestive tissue occupies the embryonic shell. Otherwise, the entire visceral hump remnant consists of pallial structures. Both of the Thailand genera have a bilobed and folded kidney that lies transversely across the body axis with the heart only partly overlapping the kidney. The ureter also has been shifted to a transverse position, but retains its sigmurethrous pattern. *Parmacella* has the kidney shortened and thickened, with the heart shifted transversely, lying beneath and deeply indenting the kidney surface. The ureter occupies essentially an unchanged topographic position. Since the intestinal looping of the Thailand genera remains at least partially within the visceral hump (see Solem, 1966, p. 69, fig. 14f, p. 73, fig. 16a, p. 89, fig. 21a, and p. 91, fig. 22c), whereas in *Parmacella*, this has shifted totally into the body cavity zone, there is no direct comparison of looping patterns. Concomitant with this, is a reduction of proportionate anterior body cavity stomach size in *Parmacella* compared with the Thailand genera. In *Parmacella*, the body cavity must hold genital and digestive structures that remain in (or almost in) the visceral hump region for both *Muangnua* and *Austenia*. Reduction of proportionate stomach volume within the cavity was mandatory.

Apparently, there also is a different strategy in regard to genital structures. In *Parmacella*, development of the adult genitalia starts at a fairly small size. Although portions will show immaturity, differentiation of organs is well marked, even at half maximum observed size. In contrast, the helicarionids are notorious for the high percentage of immature examples (see Blanford and Godwin-Austen, 1908, p. 79 and Solem, 1966, pp. 72, 85). Even quite large individuals show slight evidence of even prostate-uterus area differentiation, much less terminal genitalia development. Apparently, the genital maturation occurs in a very brief period, thus intensively using energy resources for this process, but not tying up energy resources in protoplasm of a differentiated genital tract over a long time period. In *Parmacella*, there seems to be a slow, long-term development, requiring much less concentrated energy use, but also locking up this energy in formed protoplasm.

Parmacella (Proparmacella) rutellum (Hutton, 1849). Figures 16-19.

Parmacellus rutellum Hutton, 1849, Jour. Asiatic Soc. Bengal, **18**, pp. 649-650—Kandahar, Afghanistan.

Vitrina baccata Hutton, 1849, Jour. Asiatic Soc. Bengal, **18**, p. 650—Melmandeh, between Kojuck Pass and Kandahar, Afghanistan; Godwin-Austen, 1914, Land and Freshwater Mollusca of India, **2**, (12), p. 316-317.

Girasia rutellum (Hutton), Godwin-Austen, 1888, Land and Freshwater Mollusca of India, 1, (6), pp. 216-217.

Parmacella kainarensis Simroth, 1912, Ann. Musée Imp. Sciences, St. Pétersbourg, **17**, Memoires, pp. 46-48, pl. 1, figs. 3, 4—Kainar, Samarkand, Russia.

Parmacella (Kandaharia) kojhakensis Godwin-Austen, 1914, Land and Freshwater Mollusca of India, **2**, (12), pp. 314-316, pl. CXLII, figs. 1-8—west side Kojhak Pass, Afghanistan.

Parmacella (Proparmacella) kainarensis Simroth, Likharev & Rammel'mier, 1962, Keys to the Fauna of the USSR, **43**, p. 403—Kainar, Bukhara, Uzbek SSR and near Stalinabad, Tadzhik SSR.

Parmacella (Proparmacella) rutellum Hutton, Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 187, fig. 15 (terminal genitalia)—widely distributed in Afghanistan.

Parmacella (Kandaharia) rutellum (Hutton), Solem, 1972, Trans. Amer. Philos. Soc., **62**, (4), pp. 61-62.

Records.—Aq Kupruk Caves, Balkh Prov. (9 specimens, FMNH 156411, FMNH 156500-3); irrigated gardens, 2,440 m. elevation, Paghman, Kabul Prov. (12 specimens, FMNH 147080, FMNH 147177).

Remarks.—Apparently widely distributed in the arc from Kandahar to the Khyber Pass and then over to Maimana, with additional localities recorded from adjacent regions in the USSR, *Parmacella rutellum* was taken from younger deposits in the Aq Kupruk Caves. Its appearance followed the disappearance of the moister zone Helicarionidae, probably indicating a shift to a drier climatic situation.

The living material from Paghman showed moderate contraction, and the attempt to make meaningful proportional measurements was not successful. Total length ranged from 33 mm. in an example with subadult genitalia to 53 mm. Several had recently fed on leaf and twig fragments, with their stomachs greatly swollen. Description of the gross anatomy has been given above.

Illustrations of the form described by Godwin-Austen (1889-1914, pp. 314-316) as *Parmacella kojhakensis* show no differences from the material reported on in this study. Despite Godwin-Austen's reservations concerning the reported color of *P. rutellum*, I have no hesitation in using that name for this complex of populations.

Family Helicarionidae
Subfamily Ariophantinae
Tribe Macrochlamydi
Genus **Syama** Godwin-Austen, 1908

Type species.—*Macrochlamys prona* Nevill, 1878.

Originally described on the basis of lacking a dart apparatus, *Syama* is here applied to a group of rather depressed species with noticeable spiral striations and more marked resting spots on the shell surface. They are all from the Western Himalayas at between 7,000 and 10,600 ft. elevation, except for the species from Afghanistan reported below which was taken at a much lower elevation. Species included here are *S. splendens* (Hutton, 1838), *S. prona* (Nevill, 1878), *S. promiscua* Blanford and Godwin-Austen, 1908, *S. masuriensis* (Godwin-Austen, 1883), *S. theobaldi* Blanford & Godwin-Austen, 1908, *S. annandalei* Godwin-Austen, 1908 and *S. hyalinoidea* (Godwin-Austen, 1910). Data on these species was summarized by Hanley & Theobald (1876), Blanford & Godwin-Austen (1908, pp. 152-157) and Godwin-Austen (1889-1914, p. 272). It is taken to be a drier zone derivative from *Macrochlamys,* which generally has a much more eastern, humid-zone distribution. Only

M. vesicula (Hutton, 1838), *M. glauca* (Benson, 1846), *M. nuda* (Pfeiffer, 1852), and *M. kuluensis* (Nevill, 1904) have been reported from the Western Himalayas and appear to overlap partly the distribution of *Syama*.

How many of the above names represent valid taxa cannot be determined at present. The descriptions are not comparable, and illustrations are of relatively poor quality. On the basis of available information, the shells from Afghanistan cannot be referred to a named form, and they are described as a new species.

Syama cavicula, new species. Figure 20a-c.

Syama sp., Solem, 1972, Trans. Amer. Philos. Soc., **62**, (4), p. 62.

Diagnosis.—Shell small for genus, diameter 9.0-11.2 mm. (mean 10.28 mm.), with 5 to 5¾ (mean 5⅜+) normally coiled whorls. Apex and spire slightly to moderately and almost evenly elevated, slightly rounded above, last ½-¾ of body whorl descending more rapidly, H/D ratio 0.453-0.556 (mean 0.490). Height 4.6-5.8 mm. (mean 5.03 mm.). Umbilicus very narrow, barely decoiling until last whorl, adult growth often straight across and narrowing opening, sometimes directed outward, contained 8.83-17.0 times (mean 11.7) in the diameter. Apical whorls 1¾, sculpture of extremely fine spiral striae, barely visible under 96x magnification, latter portion with irregular broad radial growth striae. Postnuclear whorls with broadly rounded, indistinct growth wrinkles and a less regular continuation of the spiral microsculpture. Sutures not impressed, a very slight channel developed about 0.1 mm. out from line of attachment. Body whorl very slightly compressed laterally above strongly rounded periphery, basal margin flatly extended into umbilical opening, with columellar wall strongly rounded. Aperture elongately ovate, compressed basally, inclined about 40° from shell axis. Lip simple and tapering on upper palatal and peripheral margins, basally with a moderate internal callus that is reduced on columellar wall.

Syama cavicula is considerably smaller and with a lower whorl count than most previously described species. *Syama hyalinoidea* (Godwin-Austen, 1910) is the only smaller species, with occasional specimens of *S. prona* (Nevill, 1878) and *S. promiscua* Blanford and Godwin-Austen, 1908 attaining only 12 mm. in diameter. Comparisons with limited material and original illustrations suggest subtle differences in whorl coiling, contour, and umbilical features, but the size and whorl count differences are diagnostic.

Description.—Shell large for species, with slightly more than 4¾ normally coiled whorls. Apex and spire moderately and evenly elevated, body whorl descending somewhat more rapidly, H/D ratio 0.466. Umbilicus very narrowly "V"-shaped until beginning of body whorl, then decoiling moderately rapidly, last ⅓ of body whorl with an almost straight margin, contained 9.59 times in the diameter. Apical and postnuclear sculpture as in diagnosis, without unusual features. Six resting lines visible on shell surface at irregular intervals, last just before lip. Sutures very shallow, subsutural sulcus better developed on spire than on body whorl. Periphery evenly rounded, very slightly compressed laterally above on upper palatal margin, lower

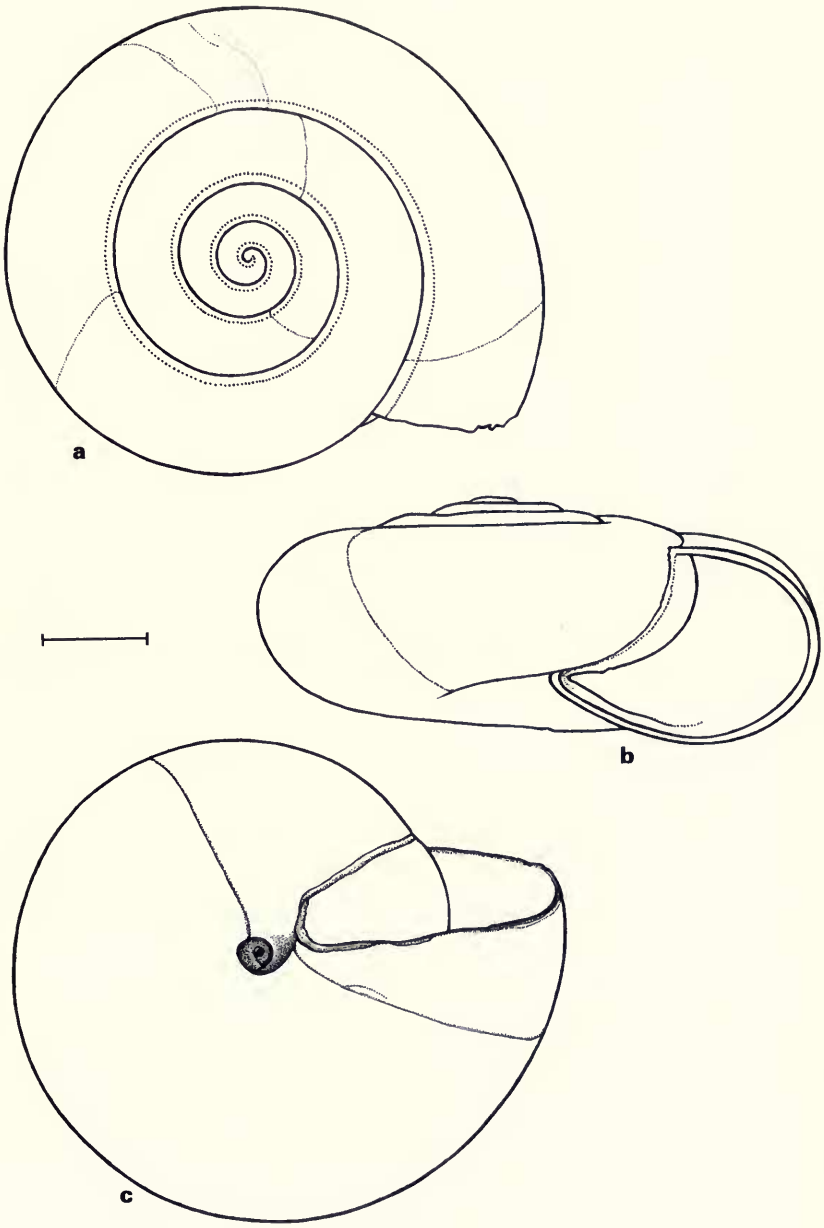

FIG. 20. *Syama cavicula*, new species, Aq Kupruk I, Cut 5p, Afghanistan, Holotype, FMNH 160719. Scale line equals 2 mm.

Table V. Size and shape variation in species of Syama

SPECIES	HEIGHT	DIAMETER	H/D RATIO	WHORLS
S. splendens	6.5	15.5	0.419	7-8
S. prona				
Naini Tal	6.75	12.25	0.551	5-1/2
Mussoorie	7.0	18.0	0.389	-----
Simla	6.0	14.0	0.429	-----
Type	5.75	12.0	0.479	6
var. huttoni	6.5	13.75	0.473	5
S. promiscua	----	12.0	-----	5-1/2
largest	7.8	15.0	0.520	6
S. masuriensis	----	18.2	-----	6
S. annandalei	8.5	16.0	0.531	5-1/4
S. theobaldi	----	13.25	-----	6
largest	8.0	15.0	0.533	-----
S. hyalinoidea	----	7.4	----	5
S. cavicula				
$\bar{X}$ of 56 adults	5.03	10.3	0.490	5-3/8+

palatal and basal margin angled in to umbilicus and distinctly flattened, columellar margin sharply rounded. Aperture elongately ovate, compressed basally, inclined about 35° from shell axis. Parietal wall with heavy and abnormally tubercular callus, inner margin of basal lip with a moderately prominent callus. Height of holotype 5.03 mm., diameter 10.7 mm.

Holotype.—Afghanistan: Snake Cave, Aq Kupruk I, cut 5p at 250 cm. 36° 5′ N, 66° 51′ E. FMNH 160719.

Paratypes.—Total of 455 adult, juvenile, and fragmentary examples from both caves at Aq Kupruk (FMNH 156414, FMNH 156416, FMNH 156428, FMNH 156431, FMNH 156462, FMNH 156480-5, FMNH 156488-96, FMNH 156523-8, FMNH 157181).

Remarks.—*Syama cavicula* appears relatively late in the Aq Kupruk deposits and probably is indicative of relatively dry conditions. Quite probably, it still exists in the general area.

Comparisons with other described species are difficult, since few measurements and accurate illustrations have been published. Available size data is summarized in Table V. The much smaller size of the Aq Kupruk shells is obvious. Comparison with descriptions and type figures show numerous differences in pattern of

Table VI. - Variation in Syama cavicula from Aq Kupruk I

	NUMBER OF SPECIMENS	HEIGHT	DIAMETER	H/D RATIO
FMNH 156524 (cut 4L, 430 cm.)	10	5.12±0.098 (4.75-5.80)	10.51±0.091 (10.10-11.00)	0.487±0.074 (0.468-0.535)
FMNH 156484 (Cut 4L, 430 cm.)	5	4.97±0.064 (4.80-5.15)	10.37±0.097 (10.10-10.60)	0.479±0.0077 (0.453-0.495)
FMNH 156528 (cut 6P, 300 cm.)	5	5.12±0.095 (4.85-5.45)	10.26±0.083 (10.00-10.45)	0.499±0.0108 (0.464-0.529)
FMNH 156527 (cut 5N, 300 cm.	5	5.06±0.062 (4.90-5.20)	9.95±0.084 (9.65-10.10)	0.509±0.0087 (0.485-0.525)
FMNH 156480 (cut 50, 250 cm.	5	5.01±0.066 (4.85-5.15)	10.31±0.114 (10.20-10.70)	0.486±0.0045 (0.481-0.500)
FMNH 156482 (cut 50, 250 cm.)	5	5.13±0.062 (5.00-5.30)	10.56±0.170 (10.20-11.15)	0.486±0.0100 (0.457-0.517)
FMNH 156525 (cut 5P, 250 cm.)	10	4.89±0.057 (4.60-5.20)	10.27±0.080 (10.00-10.80)	0.477±0.0550 (0.454-0.498)
FMNH 156526 (cut 5M, 300+cm.)	4	4.96±0.155 (4.55-5.30)	9.58±0.197 (9.00-9.90)	0.519±0.3000 (0.469-0.556)

	WHORLS	UMBILICAL WIDTH	D/U RATIO
FMNH 156524 (cut 4L, 430 cm.)	5 1/2+(5 1/4-5 3/4)	0.96±0.052 (0.65-1.20)	11.3±0.66 (8.83-16.0)
FMNH 156484 (cut 4L, 430 cm.)	5 3/8-(5-5 1/2)	0.85±0.045 (0.75-1.0)	12.3±0.66 (10.1-13.9)
FMNH 156528 (cut 6P, 300 cm.)	5 1/2+(5 3/8-5 3/4)	0.84±0.058 (0.65-1.00)	12.5±0.87 (10.2-15.4)
FMNH 156527 (cut 5N, 300 cm.)	5 3/8-(5 1/4-5 3/8+)	0.84±0.068 (0.70-1.00)	12.1±0.91 (10.0-14.4)
FMNH 156480 (cut 50, 250 cm.)	5 1/4+(5-5 1/2-)	0.84±0.066 (0.60-1.00)	12.6±1.12 (10.70-17.00)
FMNH 156482 (cut 50, 250 cm.)	5 1/4+(5-5 1/2-)	1.07±0.037 (1.00-1.20)	9.90±0.26 (9.32-10.60)
FMNH 156525 (cut 5P, 250 cm.)	5 1/4+(5-5 1/2-)	0.92±0.048 (0.70-1.15)	11.5±0.59 (9.00-14.29)
FMNH 156526 (cut 5M, 300+cm.)	5 1/4+(5-5 1/2)	0.79±0.052 (0.70-0.90)	12.3±0.66 (11.00-13.86)

whorl coiling, spire elevation, aperture shape, or shell sculpture. In view of the limited variation found in the Aq Kupruk material, specific level recognition is necessary.

Slightly more than 10 per cent of the specimens were adult and undamaged, with all sets containing more than four adults coming

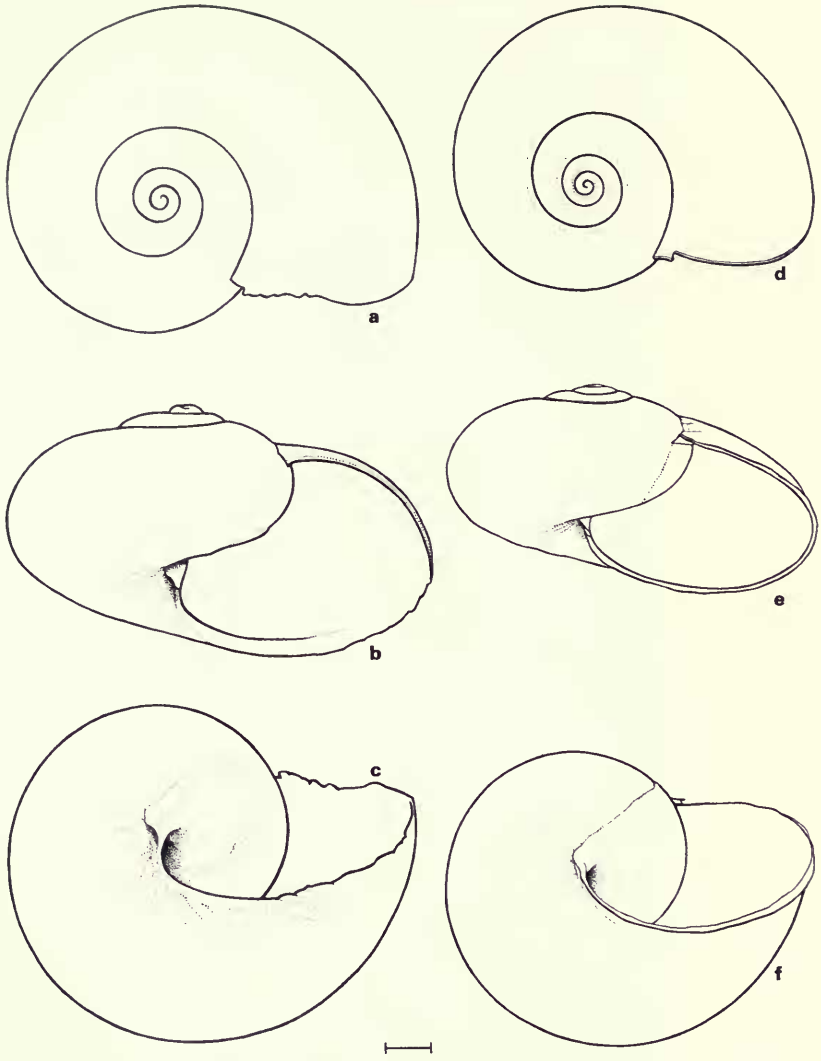

FIG. 21. **a-c**, *Parvatella flemingi* (Pfeiffer), Aq Kupruk II, Cut 5o, Afghanistan, FMNH 156452; **d-f**, *Parvatella sogdianus* (Martens), Mazar-i-Sharif, Balkh Prov., Afghanistan. Slightly juvenile. FMNH 147168. Scale line equals 2 mm.

from Aq Kupruk I. Size and shape variation is summarized in Table VI. Only one set was obviously reduced in size, the material from Cut 5M at 300+ cm., averaging 9.58 mm. in diameter. Their spires were relatively elevated, but whorl count and umbilical proportions did not differ significantly. Another set from Cut 50 at 250 cm. had

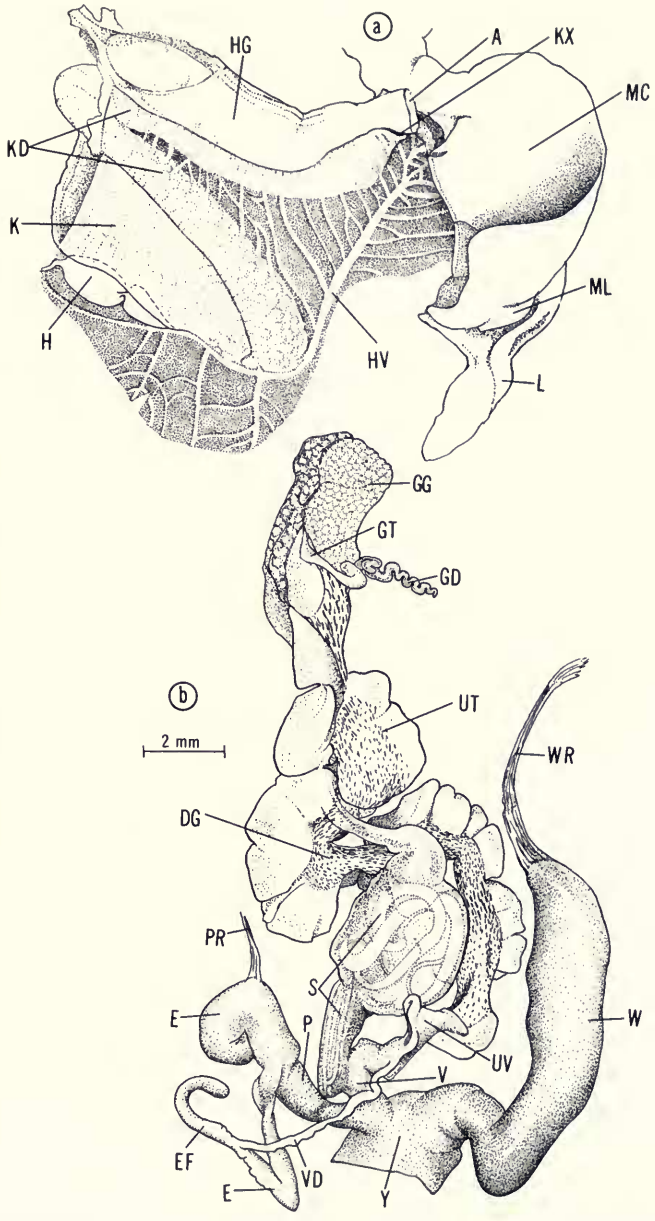

FIG. 22. *Parvatella sogdianus* (Martens), Irrigation ditch, 2 miles west of Mazar-i-Sharif, Balkh Prov., FMNH 147168: **a**, pallial region; **b**, genitalia with ovotestis omitted.

the umbilicus significantly widened, but their other measurements were not unusual.

No ecological interpretation of this variability can be offered at this time.

Genus **Parvatella** Blanford and Godwin-Austen, 1908

Considerable uncertainty exists concerning the exact relationships of the Himalayan helicarionid genera, and this report can do nothing to correct the situation. The two species reported on here have minor but consistent shell differences (fig. 21a-f), markedly distinct spermatophores (figs. 23b-d; 25c-d), and proportional differences in terminal genitalia structures. It is not possible, at this time, to relate them effectively to extralimital species or genera, since detailed accounts do not exist in the literature. Such genera as *Euaustenia* Cockerell, 1898 probably are closely related, but without study of much more material, synonymization is premature.

Detailed drawings of the functional surfaces of the terminal genitalia and of the spermatophores have been presented, but no descriptions have been drawn up because the comparative data in the literature is so sparse.

Parvatella flemingi (Pfeiffer, 1857). Figures 21a-c; 24a,b; 25a-e.

Vitrina flemingi Pfeiffer, 1857, Proc. Zool. Soc. London, **1856**, p. 324—Seinde (error, corrected to 10,000 ft. above the sea on the Murri Hills, North Punjab); Pfeiffer, 1858, Novit. Conch., **1**, p. 99, pl. 28, figs. 1-3.

Parvatella flemingi (Pfeiffer), Blanford & Godwin-Austen, 1908, Fauna British India, Mollusca, **1**, p. 147, fig. 53; Solem, 1972, Trans. Amer. Philos. Soc., **62**, (4), p. 62.

Record.—Aq Kupruk cave deposits, Balkh Prov. (19 specimens, FMNH 156451-6, FMNH 156504-6); 7 miles west of Jalalabad, 793 m. elevation, Nangarhar Prov. (8 specimens, FMNH 147172).

Remarks.—Specimens of *Parvatella flemingi* from Gharihal, Murree, Pakistan (FMNH 43349), agree with the Aq Kupruk and Nan-

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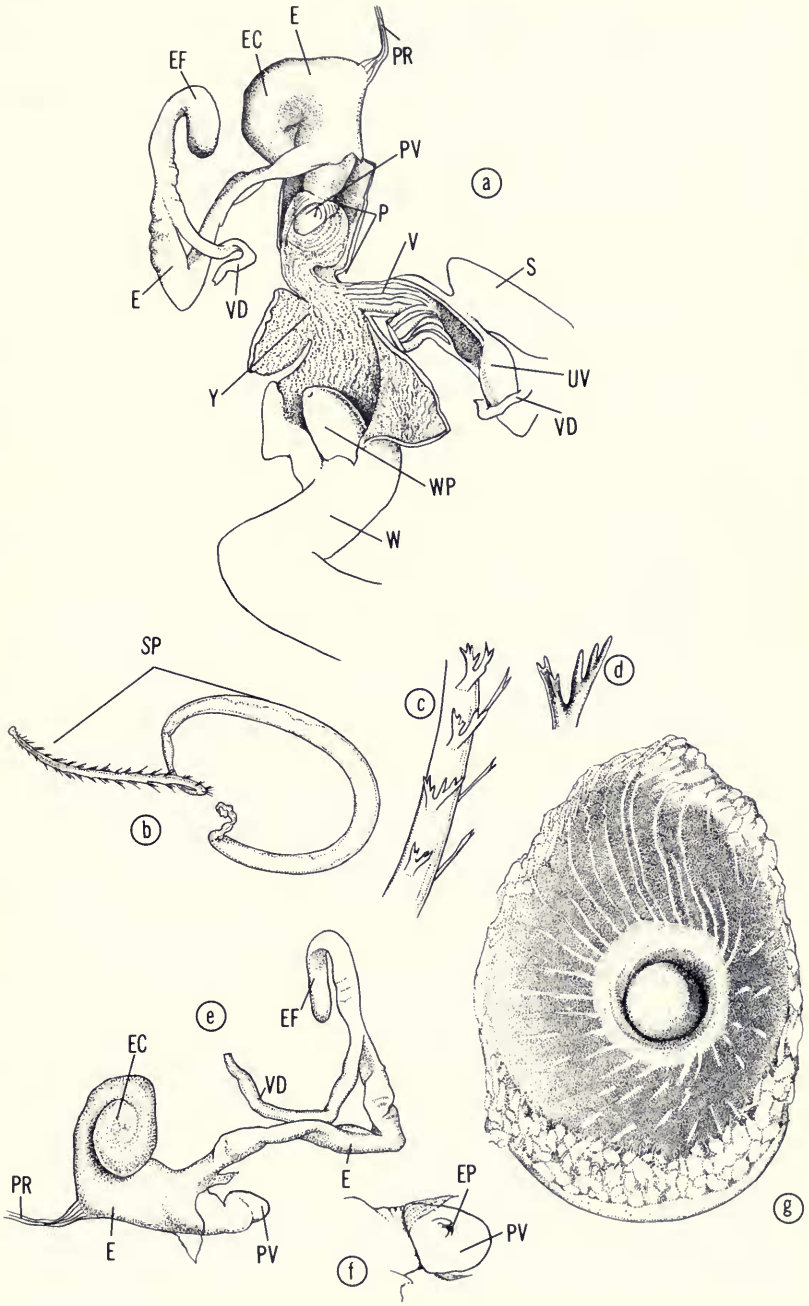
Opposite:

FIG. 23. *Parvatella sogdianus* (Martens), Irrigation ditch, 2 miles west of Mazar-i-sharif, Balkh Prov., FMNH 147168: **a**, functional surfaces of terminal genitalia from dissection figured in 22b; **b-d**, details of spermatophores stored in spermatheca of same individual; **e**, details of vas deferens (VD) and epiphallus (E) showing exact insertions of accessory organs and penial retractor (PR); **f**, vergic papilla showing epiphallic pore (EP) position in relation to tip of papilla; **g**, cross-sectional view of dart apparatus. All figures enlarged from portions of Figure 22b where a scale line is indicated.


E
EC
EF
PR
PV
a
P
V
S
E
VD
Y
UV
VD
WP
W
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b
c
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EF
EC
VD
PR
E
E
PV
EP
PV
f
g

garhar examples in microsculpture, whorl configuration, and shape. I have no hesitation in considering them to be conspecific. The largest example in the Aq Kupruk material was a fragment 26.5 mm. in diameter, which is significantly smaller than the maximum size of 42 mm. cited by Blanford & Godwin-Austen (loc. cit.). Since most examples obviously were broken, the smaller size may not have any significance. All examples came from the older strata of the caves.

Parvatella ghorbandensis Jaeckel (1956, p. 347, figs. 5,6) from "Ghorband-Tal, Hindu Kusch" measures only 10 mm. at 4½ whorls, whereas one of the Aq Kupruk shells measures 24.8 mm. in diameter with 4¾ whorls. On the basis of the type figures, there seems to be some difference in coiling pattern along with the obvious size change.

Parvatella sogdianus (Martens, 1871). Figures 21d,f; 22a,b; 23 a-g.

Helicarion sogdianus Martens, 1871, Malakol. Blätt., **18**, pp. 65-66, pl. 1, figs. 1-3—Samarkand, Asiatic Russia.

Macrochlamys sogdiana (Martens), Likharev & Rammel'meier, 1962, Keys to the Fauna of the U.S.S.R., **43**, pp. 426-427, fig. 306—Uzbek and Tadzhik Republics.

Macrochlamys (Parvatella) sogdiana (Martens), Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 188—several localities in montane areas of eastern Afghanistan.

Records.—2 miles west of Mazar-i-sharif, 386 m. elevation, Balkh Prov. (34 specimens, FMNH 147168-70); 4 miles west of Taliq-an, 884 m. elevation, Badakhshan Prov., (13 specimens, FMNH 147176); Paghman, 2,440 m. elevation, Kabul Prov. (3 specimens, FMNH 147079).

Remarks.—Samarkand specimens originating from the Möllendorff collection (FMNH 43212, FMNH 43692, FMNH 129521) compare exactly in microsculpture and shape with the Mazar-i-sharif and Taliq-an specimens. The single adult from Paghman is slightly smaller and more depressed, but may not be separable.

Under 16× magnification and in strong lateral lighting, weak periostracal folds are visible at the suture and in the valleys between the low and irregular growth ridges. In contrast to *P. flemingi*, the shell has no distinct spiral striae on the surface. Umbilical closure is achieved by a more strongly angular columellar reflection than that in *P. flemingi* (fig. 21b-e).

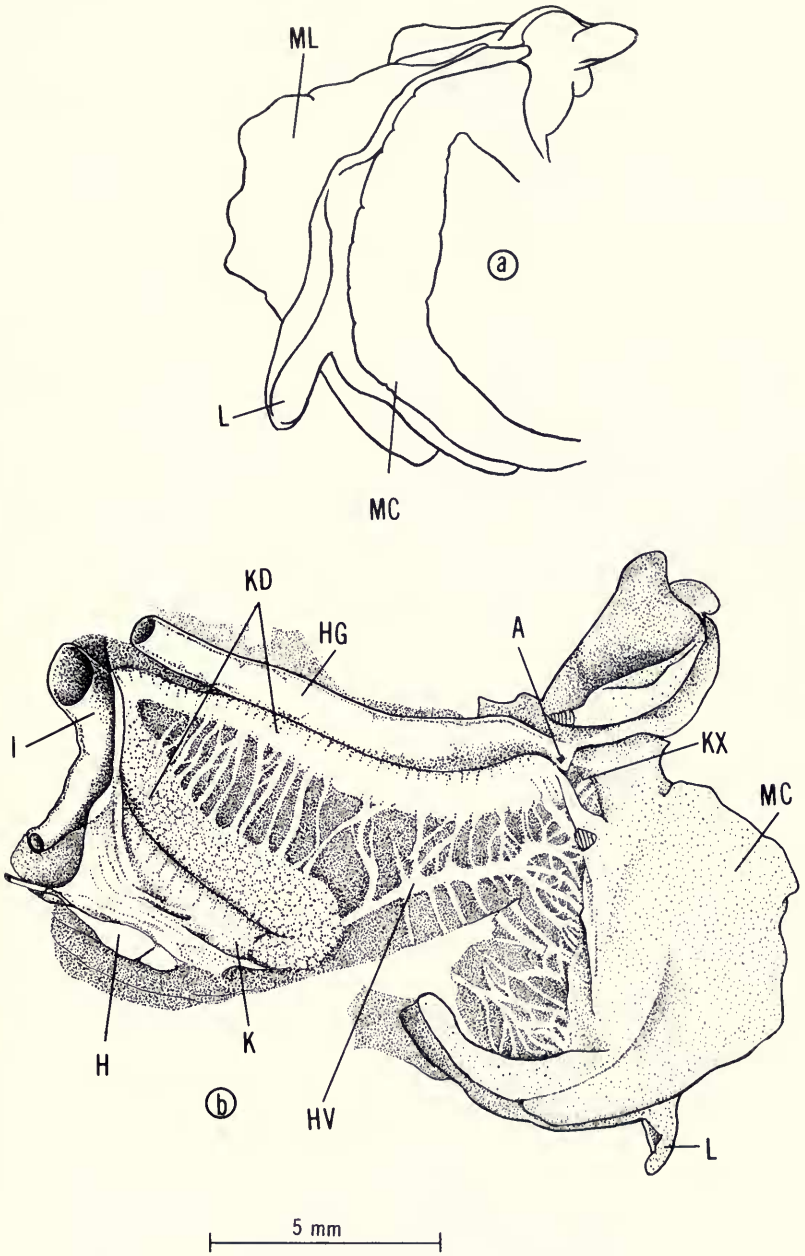
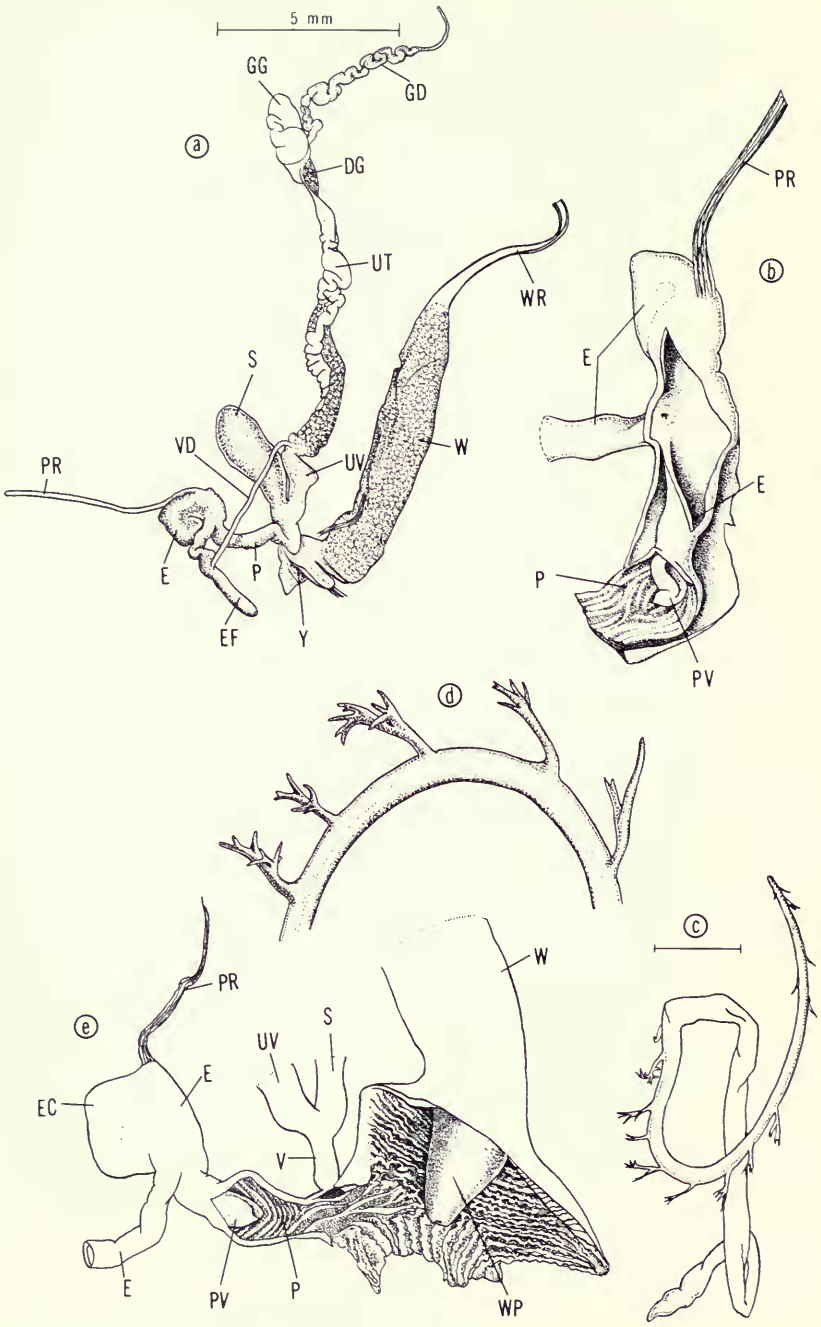


FIG. 24. *Parvatella flemingi* (Pfeiffer), Seepage area, 7 miles west of Jalalabad, Nangarhar Prov., FMNH 147172: **a**, outline of exterior section of mantle collar (MC) showing relative sizes of mantle lobe (ML) and shell lap (L); **b**, interior view of pallial complex. Scale line as marked.


5 mm
GG
GD
a
DG
UT
WR
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VD
UV
W
PR
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EF
Y
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PV
d
W
c
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PR
S
UV
E
EC
V
E
PV
P
WP

Suborder Holopoda
Superfamily Achatinacea
Family Ferussaciidae

Caecilioides bensoni Gude, 1914. Figure 7a (p. 23).

Caecilioides bensoni Gude, 1914, Fauna British India, Mollusca, **2**, pp. 375-376, fig. 121—plains of India.

Record.—Aq Kupruk, Cave I (180 specimens, various FMNH sets).

Remarks.—Measurement of 33 adults showed a range in height of 4.1-5.7 mm. (mean 4.96 mm.), with 5¾ to 6¾ whorls (mean 6⅜). All specimens were obtained from the upper strata of Snake Cave, sifted out of dirt compacted in the apertures of *Trichia* and *Subzebrinus.* This is the first locality record for this species since the original description. Whether the immature *Caecilioides* recorded from Kandahar-Kuna by Jaeckel (1956, p. 345) is this species or an introduced form is unknown. The genus is calciphilous and previously has been collected in caves.

Family Subulinidae
Subfamily Rumininae

Zootecus insularis chion (Pfeiffer, 1857). Figure 26.

Bulimus chion Pfeiffer, 1857, Proc. Zool. Soc. London, **1856**, p. 332—mouth of Indus River and in the Punjab; Hanley and Theobald, 1876, Conch. Indica, pl. 22, fig. 1.

Zootecus insularis form *chion* (Pfeiffer), Pilsbry, 1906, Man. Conch., (2), **18**, p. 112, pl. 26, fig. 32; Solem, 1972, Trans. Amer. Philos. Soc., **62**, (4), p. 63.

Zootecus chion (Pfeiffer), Gude, 1914, Fauna British India, Mollusca, **2**, p. 373.

?Zootecus insularis form *pullus* Gray, Jaeckel, 1956, Mitt. Zool. Mus., Berlin, **32**, (2), p. 345—Ghorband-Tal, Hindu Kusch at 1,950 m. elevation, Afghanistan.

Zootecus insularis (Ehrenberg), Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 185—Konar Prov., Afghanistan.

Record.—Ground near Aq Kupruk caves (70 specimens, FMNH 156598).

Opposite:

Fig. 25. *Parvatella flemingi* (Pfeiffer), Seepage area, 7 miles west of Jalalabad, Nangarhar Prov., FMNH 147172: **a**, genitalia except for ovotestis; **b**, detail of epiphallus-penis junction showing pore positions; **c-d**, structure of spermatophore removed from spermatheca of dissected specimens illustrated in *a*; **e**, functional surfaces of terminal genitalia. Figures *b-e* enlarged from portions of *a*, where scale equals 5 mm.

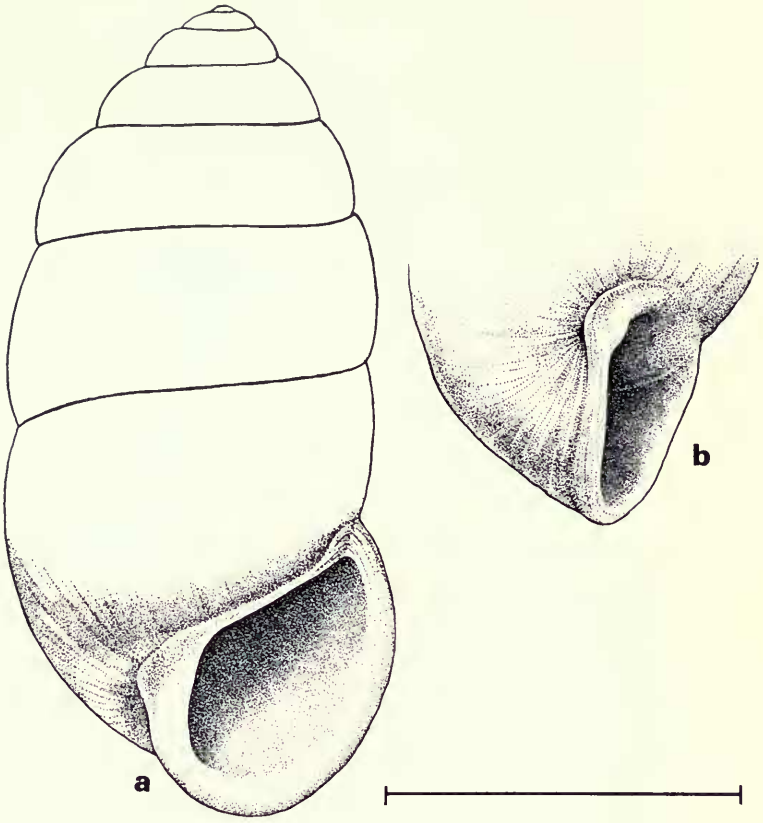

FIG. 26. *Zootecus insularis chion* (Pfeiffer), Aq Kupruk II, Balkh Prov., Afghanistan, FMNH 156598; **a**, side view; **b**, umbilical structure. Scale line equals 5 mm.

Remarks.—The range of this highly variable species extends from the Cape Verde Islands to Upper Burma. No comprehensive study of the anatomy and variation among populations has been undertaken. The material collected by Dupree agrees with form *chion*, that collected by Klappenbach has been referred to form *pullus*. Possibly, a complex of species is involved, but without much more material for study, no revision is possible. Variation in the adult specimens is summarized in Table IV, p. 30.

The absence of this species from the Aq Kupruk cave deposits is of unknown significance. Possibly, it is a recent emigrant to this area

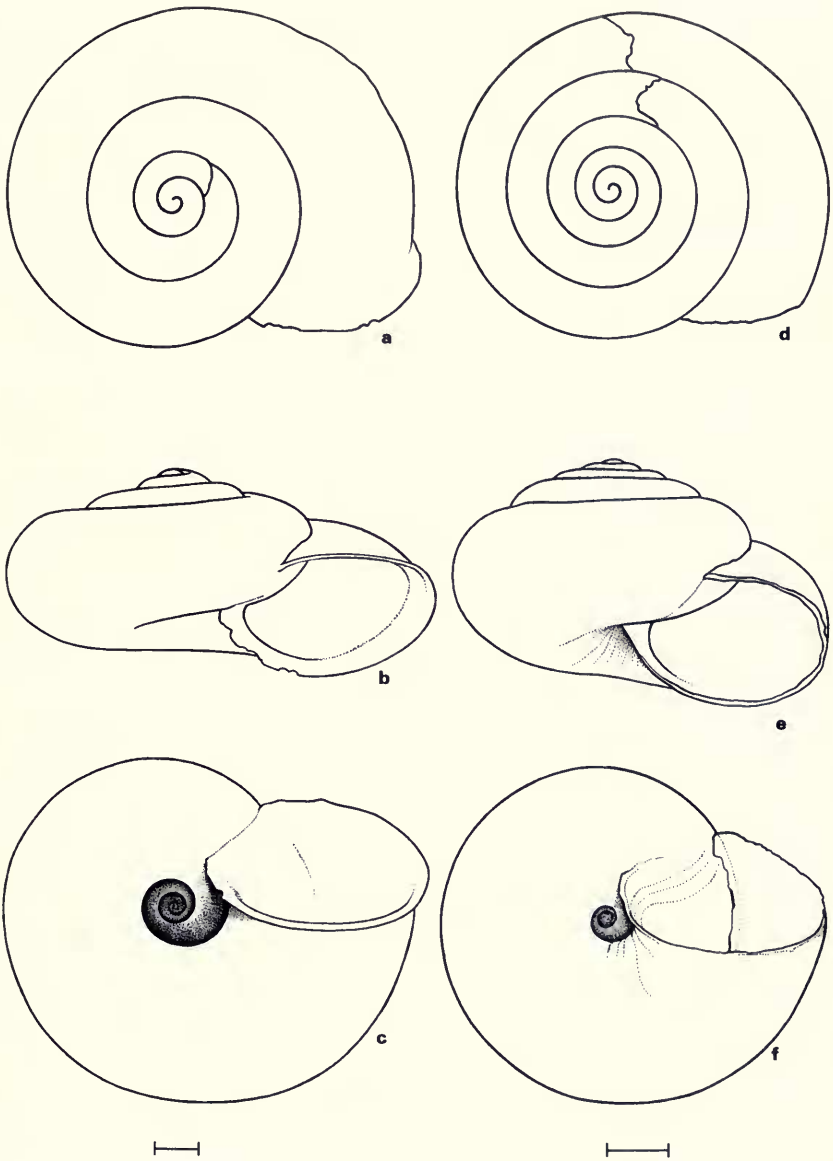

FIG. 27. **a-c**, *Bradybaena fedtschenkoi* (Martens), West of Faizabad, Badakshan Prov., Afghanistan, FMNH 147163; **d-f**, *Leucozonella rufispira* (Martens), East of Maimana, Fariab Prov., Afghanistan, FMNH 147149. Scale lines equal 2 mm.

of Afghanistan. Since the shell normally is confused with members of the Enidae, an outline drawing has been provided in Figure 26.

Superfamily Helicacea
Family Bradybaenidae
Subfamily Bradybaeninae

Bradybaena fedtschenkoi (Martens, 1874). Figure 27a-c.

Helix fedtschenkoi Martens, 1874, *in* Fedchenko's Puteshestvie v Turkestan, **2**, (1), p. 16, pl. 1, fig. 9.

Cathaica fedtschenkoi (Martens), Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), pp. 348-349, fig. 7—Faizabad, Badakshan.

Cathaica (Cathaica) fedtschenkoi (Martens), Likharev & Rammel'meier, Keys to the Fauna of the U.S.S.R. (English edition), **43**, pp. 431-432—Alai, Trans-Alai, and Zeracshanskii mountain ranges, U.S.S.R.

Helix sturanyana Rolle, 1893, *in* Kobelt's Icon. Land- und Süsswasser-Moll., N. F., **6**, p. 75, pl. 169, fig. 1086—Russian Turkestan.

Bradybaena fedtschenkoi (Martens), Schileyko, 1978, Fauna SSSR, n.s., **117**, pp. 160-161, figs. 116-118, pl. 4, fig. 39.

Record.—25 km. west of Faizabad, north-facing slope at 3,300 ft. elevation, Badakshan Prov. (14 specimens, FMNH 147163).

Remarks.—Only three specimens were adult. Their dimensions are given in Table VIII. In comparison with specimens of *Bradybaena fedtschenkoi* from Kuli Kulan, Turkestan (FMNH 39766 ex C. Brancsik), the Faizabad shells are larger and have a greater apertural inclination. Possibly, *sturanyana* is a valid subspecies, but more material is needed before making any taxonomic decision. The relationships of this form to *B. perlucens* (Rosen, 1901) also requires investigation (see Likharev & Starobogatov, 1967, p. 190).

Family Helicidae

The conservative use of a broadly defined family Helicidae is adapted here rather than splitting into several family units as proposed by Schileyko (1978). His generic allocations are utilized.

Xeropicta candaharica (Pfeiffer, 1846). Figures 28 a-c; 29-31.

Helix candaharica Pfeiffer, 1846, Proc. Zool. Soc. London, **1846**, p. 37—Candahar, Afghanistan; Reeve, 1852, Conch. Icon., **7**, *Helix*, pl. 85, fig. 456.

Helicella candaharica (Pfeiffer), Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), p. 350—Kandahar, Kandahar-Kuna, Scham-Schir-Ror near Kandahar at 950 m. elevation, Khanabad near Katagan and Hassan-Tal near Baghlan at 400 m. elevation in northern Afghanistan; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 190.

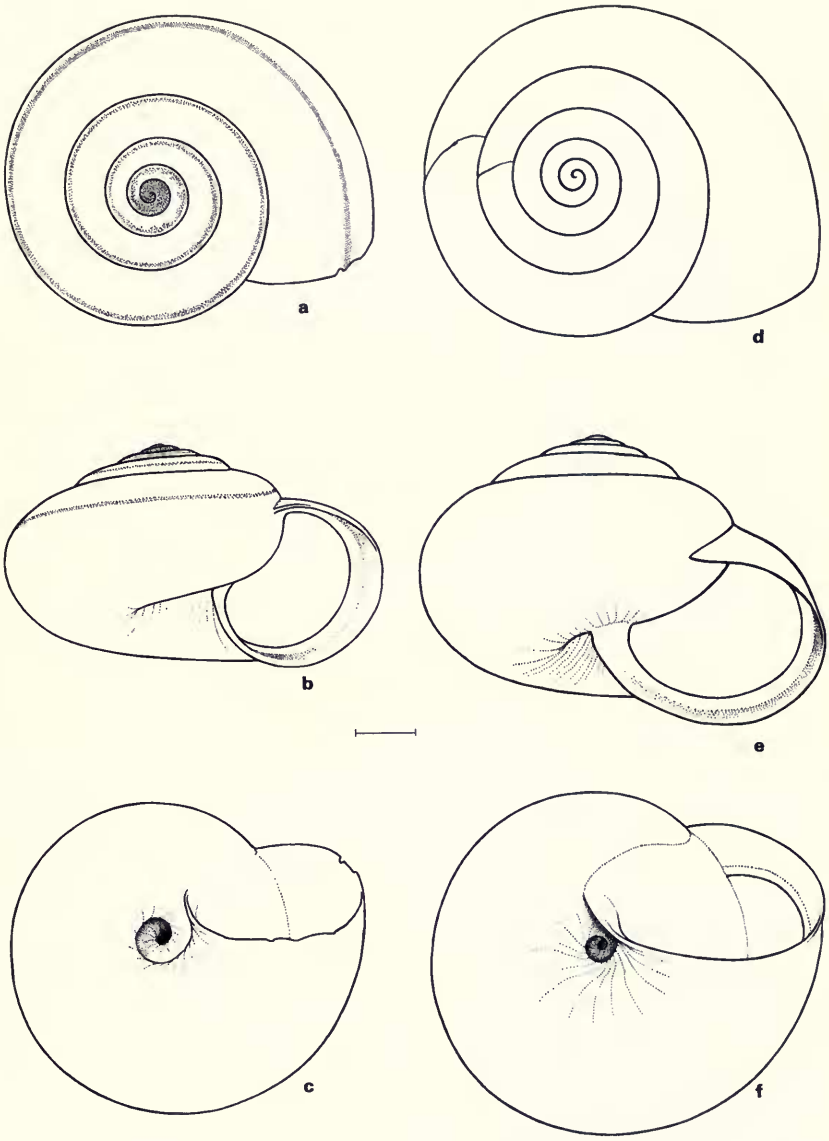

FIG. 28. **a-c**, *Xeropicta candaharica* (Hutton), Kandahar, Afghanistan, FMNH 147117; **d-f**, *Euomphalia bactriana* (Hutton), Kandahar, Afghanistan, FMNH 147118. Scale line equals 2 mm.

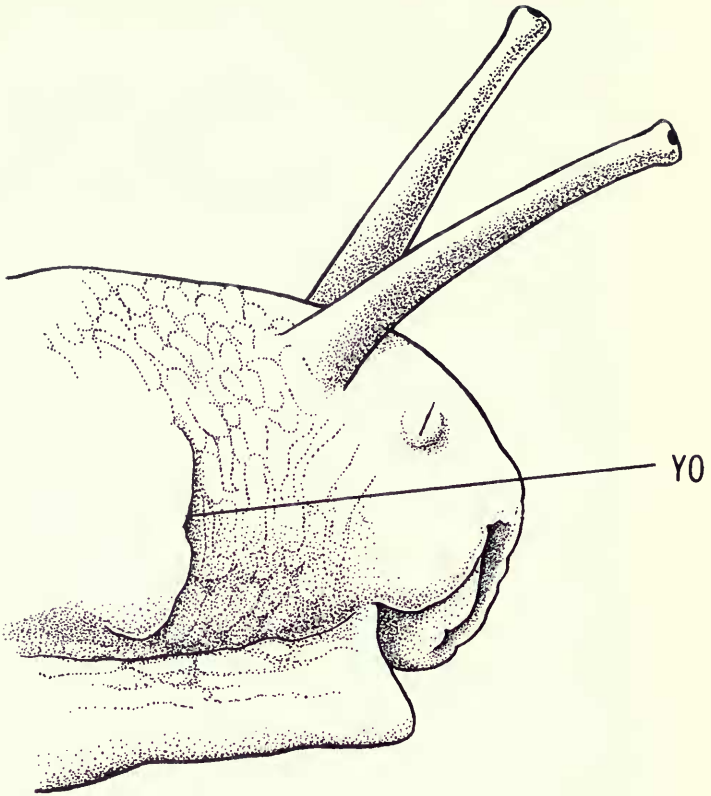

FIG. 29. *Xeropicta candaharica* (Hutton), Kandahar, Afghanistan, FMNH 147122. Right side of head showing relative positions of genital pore and tentacles.

Helicella (Xeropicta) candaharica (Pfeiffer), Likharev & Rammel'meier, 1962, Keys to the Fauna of the U.S.S.R., **43**, p. 486—Kopet Dag to Fergana Mountains of Central Asia.

Xeropicta candaharica (Pfeiffer), Schileyko, 1978, Fauna SSSR, n.s., **117**, pp. 222-223, figs. 250, 251, pl. 11, fig. 108.

Record.—Arghandab drainage canals, 1,425 m. elevation, Kandahar, Kandahar Prov. (64 specimens, FMNH 147115, FMNH 147117, FMNH 147119, FMNH 147122, FMNH 147130); irrigated area 5 miles south of Kunduz, 1,800 m. elevation, Baghlan Prov. (96 specimens, FMNH 147164); cultivated gardens, 945 m. elevation, Girishk, Helmand Prov. (13 specimens, FMNH 147157-9, FMNH 147160); Herat, 915 m. elevation, Herat Prov. (11 specimens, FMNH 147154, FMNH 147156).

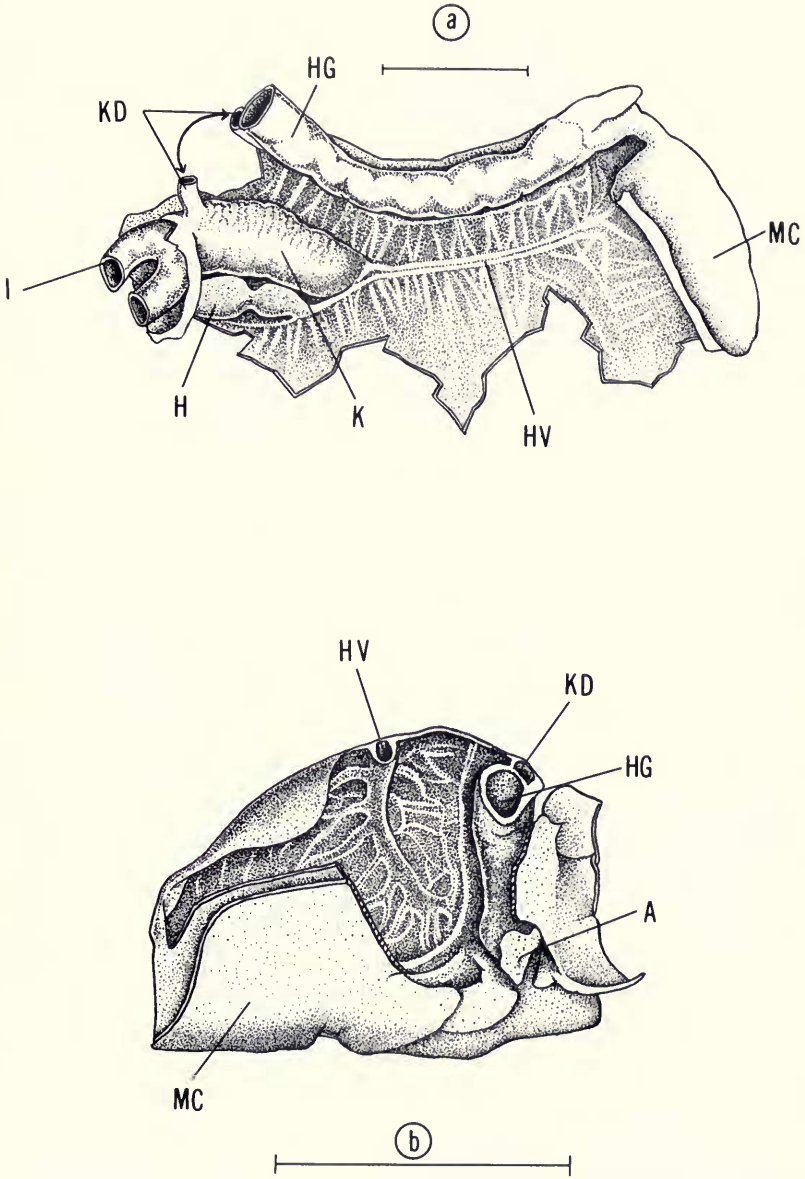

FIG. 30. *Xeropicta* aff. *candaharica* (Pfeiffer), Girishk, Helmand Prov., Afghanistan, FMNH 147157: **a**, pallial region; **b**, anterior portion of pallial region with cross-section showing position of secondary ureter (KD) under hindgut (HG). Scale lines equal 5 mm.

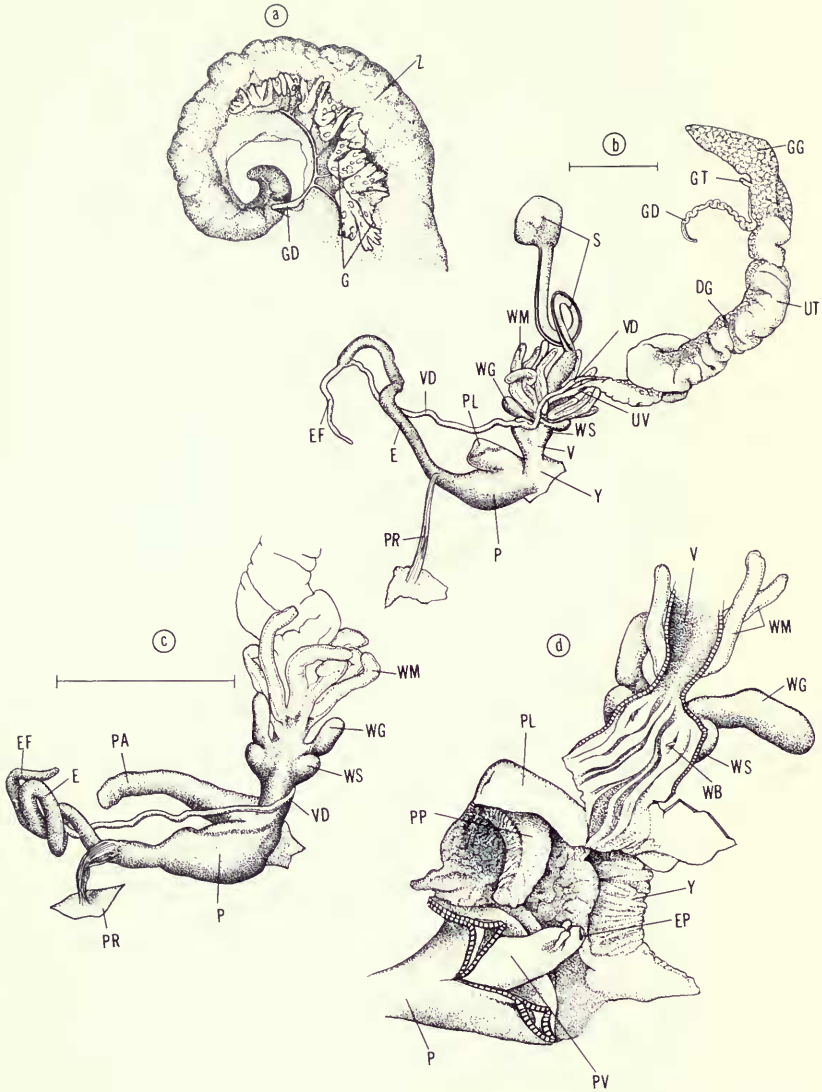

FIG. 31. *Xeropicta* aff. *candaharica* (Pfeiffer). **a**, **c**, Girishk, Helmand Prov., Afghanistan, FMNH 147157: *a*, ovotestis position in liver, greatly enlarged; *c*, terminal genitalia showing long penial appendix. *Xeropicta candaharica* (Pfeiffer). **b**, **d**, Kandahar Prov., Afghanistan, FMNH 147122: *b*, genitalia with short penial appendix (PA); *d*, interior of terminal genitalia. Scale lines equal 5 mm.

Table VII. - Variation in Euomphalia and Xeropicta

	NUMBER OF SPECIMENS	HEIGHT	DIAMETER	H/D RATIO
Euomphalia bactriana				
Kandahar (XI-1) FMNH 147128-31	11	8.00±0.215 (7.20-9.20)	11.14±0.287 (10.25-12.95)	0.719±0.0113 (0.653-0.768)
Kandahar (XI-8) FMNH 147118	56	8.04±0.106 (6.40-9.60)	11.54±0.129 (9.05-13.65)	0.697±0.0039 (0.627-0.761)
Kandahar (XI-8) FMNH 147123-4	106	7.80±0.081 (6.20-10.00)	11.27±0.106 (9.15-14.35)	0.692±0.0030 (0.620-0.795)
Kandahar (XI-9) FMNH 147121	15	8.33±0.242 (6.60-10.30)	11.73±0.311 (9.00-13.55)	0.711±0.0112 (0.592-0.761)
Herat FMNH 147155	30	7.71±0.147 (6.55-9.65)	10.89±0.159 (9.80-13.10)	0.708±0.0064 (0.623-0.756)
Xeropicta candaharica				
Kunduz FMNH 147164	6	5.91±0.145 (5.40-6.40)	9.03±0.317 (8.20-10.25)	0.657±0.0186 (0.600-0.709)
Kandahar FMNH 147130	5	6.88±0.346 (5.65-7.60)	11.69±0.259 (11.05-12.40)	0.588±0.0241 (0.496-0.633)
Kandahar FMNH 147122	8	7.49±0.267 (6.50-8.50)	12.35±0.195 (11.40-13.00)	0.606±0.0178 (0.552-0.705)
Kandahar FMNH 147115,-7,-9	10	7.72±0.161 (6.80-8.45)	12.49±0.364 (10.50-14.10)	0.621±0.0152 (0.521-0.686)

	WHORLS	UMBILICUS	D/U RATIO
Euomphalia			
FMNH 147128,-31	5 5/8+(5 3/8-6)	1.12±0.038 (0.85-1.30)	10.06±0.366 (8.00-12.12)
FMNH 147118	5 5/8+(5 1/4-6 1/4)	1.09±0.031 (0.50-1.50)	11.10±0.349 (8.00-20.20)
FMNH 147123-4	5 5/8+(5 1/4-7)	1.11±0.019 (0.65-1.55)	10.55±0.196 (7.71-18.23)
FMNH 147121	5 1/2+(5 1/4-5 7/8)	1.17±0.054 (0.75-1.50)	10.19±0.367 (8.07-12.30)
FMNH 147155	5 3/4+(5 1/2-6 1/4)	1.12±0.048 (0.60-1.60)	10.16±0.406 (7.13-16.92)
Xeropicta			
FMNH 147164	5 3/8-(5 1/8-5 3/4)	1.40±0.090 (1.20-1.70)	6.53±0.271 (5.76-7.50)
FMNH 147130	5 5/8+(5 3/8-6)	2.22±0.175 (1.80-2.75)	5.39±0.414 (4.51-6.78)
FMNH 147122	5 1/2+(5 1/4-5 3/4)	2.10±0.071 (1.80-2.40)	5.92±0.190 (5.21-6.61)
FMNH 147115,-7,-9	5 1/2+(5 3/8-5 3/4)	2.15±0.080 (1.80-2.55)	5.86±0.177 (5.35-6.65)

Remarks.—Although much of the material was juvenile, conchological variation in a few sets of adults is summarized in Table VII. Differences between the Kandahar sets, which were collected on different days and from slightly different populations, are just below or well below the level of statistical significance. Comparing FMNH 147122 and FMNH 147130 for diameter, with 11 degrees of freedom, "*t*" is 2.0623. The larger variance for the sets FMNH 145115, -7, -9 makes comparison with the smallest Kandahar sample (FMNH 147130) less near the level of significance, "*t*" equals 1.4462 with 13 degrees of freedom, despite the larger mean diameter. Since FMNH 147130 material averages ⅛ whorl more, but still is 0.67 mm. smaller than the second smallest (FMNH 147122), there evidently are real size differences between populations. The Kunduz shells obviously are dwarfed compared with the Kandahar examples.

Dissection of material from Kandahar (fig. 31b, d) and Girishk (figs. 30, 31a, c) showed significant differences in the terminal male genitalia. The Kandahar examples have a short penial lobe (fig. 31b PL) whose length is significantly less than the distance from the atrium to penial retractor insertion and whose apex is bluntly truncated. In the Girishk examples, an actual penial appendix is very long and finger-like (fig. 31c, PA) and equals the distance from atrium to penial retractor insertion. Internally, the Kandahar examples (fig. 31d) have a large, fleshy penial pilaster (PP) arising from the penial lobe apex. Its sides are free of the walls and it is verge shaped. In the Girishk examples, this is replaced by a long rugose pilaster that runs along one wall of the appendix. Although shells from the two areas appear to have equivalent conchological variation, so few Girishk adults were available that statistical comparisons were not possible.

The basic anatomical review of *"Helicella"* (Hesse, 1934) was concerned only with the retracted appearance of the terminal genitalia, and very little detail of the functioning surfaces was shown. The outline drawings of *Xeropicta* species in Hesse (loc. cit., pl. 6) show considerable variation in the shape and size of the penial appendix. The dart apparatus of these taxa agree quite closely with those seen in the Afghanistan specimens, so that generic reference to *Xeropicta* is reasonable. Unquestionably, there is a complex of species involved, but the materials needed to work out these problems are not available. The topotypes of *X. candaharica* dissected here (fig. 31b, d) do not agree with the anatomy illustrated for Russian specimens

by Schileyko (1978, p. 222, figs. 250, 251). In having the truncated penial appendix and verge-like stimulator, *Xeropicta candaharica* differs significantly from other taxa assigned to *Xeropicta* (Schileyko, 1978, pp. 220-221, figs. 245-249). The specimens from Girishk (fig. 31c) agree in the form and internal structure of the penis appendix with Russian *Xeropicta*, but differ in the shorter epiphallic flagellum and details of the mucous gland. At the present time, the Girishk specimens can be referred to *Xeropicta*, but not to a species, whereas the Kandahar examples can be referred to the species *candaharica* (Pfeiffer, 1846), but only tentatively (and probably incorrectly) to the genus *Xeropicta*. They are not the same species, but since no clear conchological differences can be outlined, I have lumped their treatment together.

For the convenience of future workers, a description follows of the soft parts from topotypic Kandahar material (FMNH 147122).

One item of general interest in the anatomy concerns the relationship between the hindgut (HG) and secondary ureter (fig. 30b, KD). In typical sigmurethrans, the secondary ureter lies partly on the lung roof and partly overlapping onto the *lower* side of the hindgut. In *Helicella candaharica*, it has shifted drastically to lie directly *above* the hindgut, actually separating the pallial hindgut from its normal position at the parietal-palatal margin.

Description of the soft parts.—Foot and tail equal to shell diameter in length, truncated anteriorly, bluntly tapering at posterior tip. Sole undivided, irregular transverse folds present in preserved material. Head projecting well in front of foot, ommatophores long with small eyespot. Gonopore (fig. 29, YO) located well behind and slightly below right rhinophore, distinctly behind and markedly below right ommatophore.

Body color yellow-white in preservative, without darker markings.

Pneumostome below and outside anus, distinctly separate. A complex groove and ridge pattern (fig. 30b) just at entrance. Anus (A) opening above pneumostome with longitudinally puckered slit through mantle collar, external ureteric pore opening beside anus. Urinary chamber a simple groove on upper edge of anal groove through mantle collar.

Pallial region (fig. 30a, b) extending slightly more than ⅓ whorl apically. Lung roof heavily crossveined between hindgut and pulmonary vein; no granulations or pigment spots. Kidney (K) about 6.7 mm. long, anterior portion finger-shaped, with abruptly broadened apical quarter above pericardium, broadening achieved by upward extension of one margin to barely touch hindgut. Ureter (KD) at first occupying upper half of inner kidney surface, reflexing apically to pass above hindgut (fig. 30a, b) and continue anteriorly to external ureteric pore located just above anus and with a narrow groove on upper anal surface through mantle collar. Heart (H) about ⅔ length of kidney, slightly angled to hindgut, posteriorly passing above part of intesti-

nal loop. Principal pulmonary vein (HV) extending almost to mantle collar edge, sides thick and tapering to thin apex (fig. 30b), numerous lateral branches, particularly toward hindgut. Hindgut (HG) angling downward from parietal-palatal margin immediately after pallial cavity apex, producing a distinct groove in outer side of albumen gland. Ovotestis (fig. 31a, G) occupying half whorl above stomach apex, several groups of short acini lying perpendicular to shell axis, opening through separate ducts into a narrow collecting tubule. Hermaphroditic duct (fig. 31b, GD) narrow, tightly and flatly kinked within connective tissue membrane to back of albumen gland, bound to albumen-prostate angle, abruptly narrowing and ascending albumen gland surface to enter swollen portion of talon. Albumen gland (GG) long, finger-shaped, lying above pallial cavity apex, outer margin grooved by passage of hindgut during its deflection, apical portion lying on stomach surface. Talon (GT) and carrefour partly buried on inner wall of albumen gland, an inner swollen portion receiving hermaphroditic duct, outer portion of fine finger-like tubes, one nearest reflexed hermaphroditic duct longest and projecting out of albumen gland surface, shortest and innermost about half its length. Prostate (DG) of fine acini equal in size to those of albumen gland, attaching diffusely onto uterine wall. Uterus (UT) with thick glandular walls, no differentiation into specialized chambers, tapering into free oviduct.

Vas deferens (VD) coming from prostate almost at level of mucous gland apex, lightly bound to vaginal tube, reflexing at penioviducal angle, continuing bound to surface until entering epiphallus head. Epiphallus (E) long and slender, twisted and convoluted above penial retractor insertion, entering penis through a large verge below penial retractor, apically with a narrow, 4-mm. long, finger-like flagellum (EF). Penial retractor (PR) arising from diaphragm near middle of pallial cavity, inserting in a diagonal line onto epiphallus. Penis (P) tapering, internally (fig. 31c, d) with a long pointed verge. Pore terminal, sides near tip with horny protrusions. Penial appendix short and stubby, internally (fig. 31d) with large pilaster attached at apex. Atrium (Y) very short, not morphologically differentiated.

Free oviduct (UV) short, slender, joining with spermatheca to form vagina just above level of mucous glands (WM) insertion. Spermatheca (S) with head below pallial cavity apex, shaft slender to free oviduct junction, spermatophore present. Vagina (V) with paired dart sacs (WS) and accessory gland (WG) opening through single pore into vagina. More apical mucous glands (WM), 8 in number, without distinct pore openings. Darts short and conical, calcareous. Lumen of vagina with creased longitudinal pilasters.

Intestine (Z) forming a simple "S"-loop from columellar margin up across kidney base, back slightly posterior to stomach expansion, then upward to parietal-palatal margin at pallial cavity apex.

Leucozonella (L.) rufispira (Martens, 1874). Figure 27d,f.

Helix rufispira Martens, 1874, Slizynaki (Mollusca), *in* Fedchenko's Puteshestvie v Turkestan, **2**, part 1, no. 1, p. 9, pl. 1, fig. 7, pl. 3, fig. 38—Sarafschan.

Cathaica rufispira rufispira (Martens), Yen, 1939, Abhl. Senckenb. Naturforsch. Ges., **444**, p. 142, pl. 14, fig. 60—Schink-Tal, Turkestan.

Cathaica rufispira hispida Jaeckel, 1956, Mitt. Zool. Mus., Berlin, **32**, (2), p. 349, fig. 8a-d—Sarekanda Mts., 4,100 m., Badakschan, Afghanistan.

Table VIII. - Variation in Bradybaena and Leucozonella.

	NUMBER OF SPECIMENS	HEIGHT	DIAMETER	H/D RATIO
Bradybaena fedtschenkoi				
FMNH 147163	3	9.87±0.203 (9.5-10.2)	18.98±0.503 (18.0-19.65)	0.520±0.017 (0.492-0.550)
Leucozonella rufispira				
FMNH 147149 Maimana, Fariab Prov.	17	7.98±0.143 (6.8-8.85)	13.00±0.181 (11.65-14.05)	0.614±0.006 (0.555-0.648)
FMNH 156433 Aq Kupruk I, cut 4L: 480 cm.	22	9.16±0.131 (8.45-11.4)	13.05±0.084 (12.5-14.1)	0.702±0.008 (0.640-0.803)
FMNH 156422 Aq Kupruk I, cut 5m: 250 cm.	22	9.45±0.154 (8.2-11.3)	13.23±0.092 (12.4-13.9)	0.715±0.012 (0.615-0.860)
FMNH 156432 Aq Kupruk I, cut 5n: 250 cm.	22	9.84±0.115 (8.70-10.8)	13.27±0.095 (12.4-14.1)	0.743±0.011 (0.668-0.803)
FMNH 156419 Aq Kupruk I, cut 5o: 250 cm.	25	9.31±0.105 (8.2-10.3)	13.20±0.070 (12.5-14.0)	0.706±0.008 (0.626-0.791)

	WHORLS	UMBILICUS	D/U RATIO
Bradybaena fedtschenkoi			
FMNH 147163	4 5/8-(4 1/2-4 3/4)	4.17±0.060 (4.05-4.25)	4.56±0.162 (4.29-4.85)
Leucozonella rufispira			
FMNH 147149	5 5/8+(5 3/8-6)	1.75±0.018 (1.6-1.85)	7.44±0.087 (6.84-7.91)
FMNH 156433	5 1/8-(4 3/4-5 1/4)	1.61±0.029 (1.42-1.90)	8.16±0.120 (7.25-9.2)
FMNH 156422	5 1/8-(4 5/8-5 3/8)	1.70±0.037 (1.33-2.01)	7.86±0.171 (6.18-9.89)
FMNH 156432	5 1/8(4 3/4-5 1/2)	1.71±0.035 (1.47-2.01)	7.82±0.143 (6.50-8.85)
FMNH 156419	5 1/8(4 5/8-5 7/8)	1.67±0.036 (1.37-2.10)	7.96±0.163 (6.20-9.75)

Eulota (Leucozonella) rufispira (Martens), Likharev & Rammel'meier, 1962, Keys to the Fauna of the U.S.S.R. (English translation), **43**, p. 456—Samarkand, Tashkent and Fergana regions of Uzbek SSR and Tadzhik SSR.

Trichia rufispira (Martens), Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, pp. 190-191, fig. 19 (anatomy)—vicinity of Maimana, Fariab Prov., Afghanistan; Solem, 1972, Trans. Amer. Philos. Soc., **62**, (4), pp. 63-64.

Leucozonella (Leucozonella) rufispira (Martens), Schileyko, 1978, Fauna SSSR, n.s., **117**, pp. 173-175, figs. 145-147, pl. 5, figs. 49, 50.

Record.—Aq Kupruk cave deposits, Balkh Prov. (6,741 specimens, many sets in FMNH); 25 miles east of Maimana, 1,220 m. elevation, Fariab Prov. (64 specimens, FMNH 147146, FMNH 147149); bank of dry irrigation ditch, 7 miles south of Herat, Herat-Kandahar Road, 915 m. elevation, Herat Prov. (1 specimen, FMNH 147151).

Remarks.—The classification of this species is based on the dissections of Likharev & Starobogatov (1967) and Schileyko (1978). The radical changes in generic position indicated in the synonymy above suggest the uncertainty of helicoid classification.

Measurement of the material from Aq Kupruk cave showed no major chronological variations (table VIII) in size or shape (Solem, 1972, p. 64).

Euomphalia bactriana (Hutton, 1849). Figures 28d-f; 32.

Helix bactriana Hutton, 1849, Jour. Asiatic Soc. Bengal, **18**, p. 651—Candahar, Afghanistan; Reeve, 1854, Conch. Icon., **7**, *Helix*, pl. 195, fig. 1376.

Cathaica bactriana (Hutton), Gude, 1914, Fauna of British India, Mollusca, **3**, pp. 209-210 (partly).

Euomphalia bactriana (Hutton), Hesse, 1931, Zoologica, **31**, (81), p. 20, pl. 3, fig. 16—genitalia; Jaeckel, 1956, Mitt. Zool. Mus. Berlin, **32**, (2), pp. 350-351, figs. 9,10—Kandahar, Kandahar-Kuna, Bashgul-Tal at 1,100 m. in Nuristan; Likharev & Starobogatov, 1967, Tr. Zool. Inst., Akad. Nauk SSSR, **42**, p. 191—Herat and Kandahar regions.

Euomphila (sic) bactriana Hutton, Starmühlner & Edlauer, 1957, Sitzungsber. Österr. Akad. Wiss., Math.-Naturwiss. Kl., **166**, (9-10), pp. 475-476, fig. 15—Herat and Kandahar, Afghanistan.

Records.—Herat, 915 m. elevation, Herat prov. (42 specimens, FMNH 147155); 7 miles south of Herat, Herat Prov. (2 specimens, FMNH 147150); Arghandab drainage irrigation canals, 1,425 m. elevation, Kandahar, Kandahar Prov. (262 specimens, FMNH 147118, FMNH 147121, FMNH 147123-4, FMNH 147128, FMNH 147131).

Remarks.—Size and shape variation is summarized in Table VII. The shells from Herat (FMNH 147155) are smaller in diameter, despite averaging a quarter whorl more than the largest Kandahar shells (FMNH 147121). For these two sets, the size difference is statistically significant, since with 43 degrees of freedom, "*t*" is 2.6745, but comparison with the smallest Kandahar set (FMNH 147128, -31) gives a "*t*" of only 0.7931. Comparisons between the various Kandahar sets yielded "*t*" values of less than significant level. There is thus no demonstrable geographic difference between

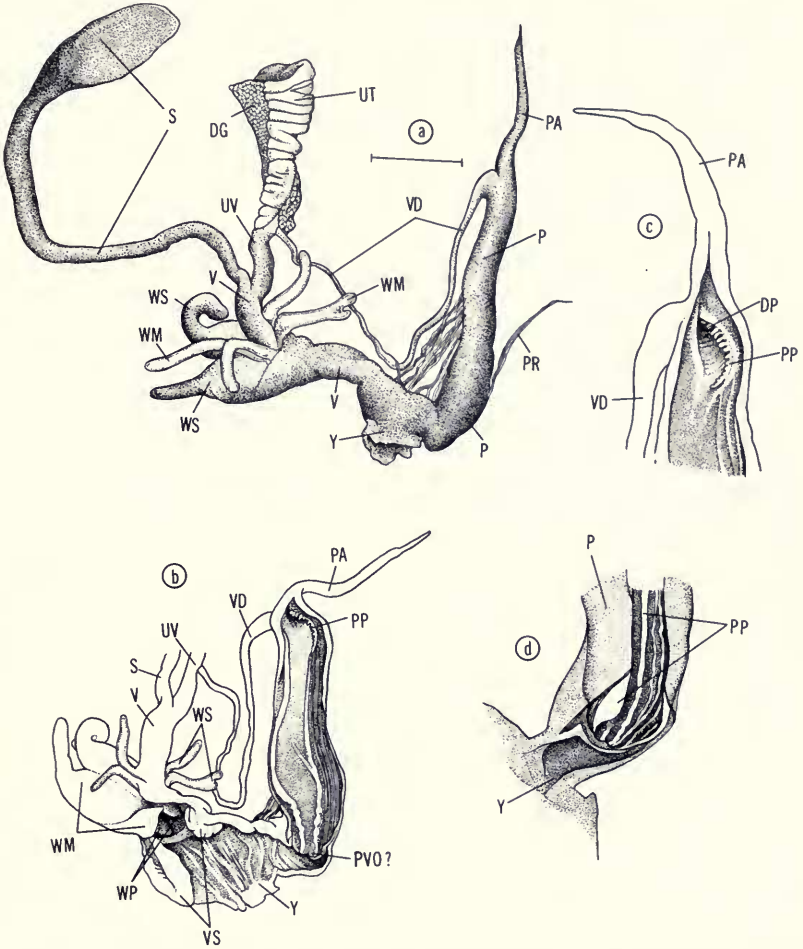

FIG. 32. *Euomphalia bactriana* (Hutton), Kandahar, Kandahar Prov., Afghanistan, FMNH 147118: **a**, genitalia of postpallial region; **b**, interior of terminal genitalia showing vaginal pilasters (VS) and position of darts (WM); **c**, detail of entrance from vas deferens into apex of penis; **d**, detail of penis-atrium junction. Scale line equals 2 mm.

the populations. Other mean parameters are so nearly identical that no statistical tests were needed. The cited localities confirm earlier records.

Generic reference of this species follows Hesse (1931, p. 20, pl. 3, fig. 16), who provided an outline sketch of the terminal genitalia. Jaeckel (1956) provided less detailed data on the jaw and terminal

genitalia. Dissection of material from Kandahar (FMNH 147118) showed several additional significant features. The four mucous glands (WM), which may be partly split, but mostly are simple, insert onto the vagina (V) above the entrance of the paired dart glands (fig. 32b). Together with the dart apparatus (WS), the mucous glands are enveloped in a muscle sheath (fig. 32a). Internally (fig. 31b), the muscular papillae (WP) of the dart apparatus are flanked by two stimulatory ridges (VS), one of which seems to serve as a potential plug to the upper vagina. Numerous muscle threads bind the vas deferens (VD) and lower penis (P) to the vagina (fig. 32a), and the penial retractor muscle (PR) arises from the body wall on the left side and inserts well down on the penis shaft. Internally (fig. 32c), the vas deferens (VD) enters through a simple pore (DP) flanked by a combed ridge (PP). The penis shaft walls are heavily muscular with two broad and many narrow longitudinal pilasters that become more prominent in the lower part near the penis base. At the atrial level, the penis terminates in a puckered pore (fig. 32b, PVO?) with accessory lamellar circular ridge around its base (fig. 32d).

Although the simple mucous glands differ from those found in the genotype, *E. strigella* (Draparnaud) (see Schileyko, 1978, p. 270. fig. 343), detailed study of other species will be necessary to evaluate the significance of this change and to assign *E. bactriana* to a more narrowly defined generic unit. Schileyko (1978) has proposed that there are a number of genera that should be grouped as the Euomphalinae Schileyko, 1978. His genera, including elevation to full genera of most subgenera and sections of *Euomphalia* in the sense of Hesse (1931) and Likharev & Rammel'meier (1962), are based on differences in the penis cross-section, length, and changes in the dart apparatus. The features shown by *Euomphalia bactriana* do not agree exactly with any of his generic units. The presence of vaginal stimulators (fig. 32b, VS) and very short tip to the verge (fig. 32b, d) are distinctive. Schileyko (1978) did not illustrate the pattern of vas deferens entrance in any of his taxa, and thus direct comparisons are not possible. Quite probably, a new generic unit will be necessary for *E. bactriana*, but without having personally dissected and studied other Euomphalinae in the sense of Schileyko (1978), I prefer not to add another generic name to the literature and have retained a more broadly defined generic concept.

SUMMARY

The 37 taxa collected by the Street Expedition and from Dupree's excavation compare favorably with the 53 taxa reported by Likharev & Starobogatov (1967). Of the 37 taxa, 10 were not known previously from Afghanistan. An additional four species had been reported earlier, but were not taken during the Russian survey. At present, 63 taxa of mollusks have been collected in Afghanistan during the 1960's; an additional 10 species were recorded earlier, but have not been taken in recent years.

The probability of additional taxa existing is very high, particularly among the Helicidae and Enidae. Since the Street collections were made incidentally to mammal collecting, the relatively high percentage of unrecorded taxa suggests that only the tip of Afghanistan molluscan diversity has been sampled.

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APPENDIX

Anatomical Abbreviations

A	anus
B	buccal mass
BR	buccal retractor muscle
CR	columellar retractor muscle
DG	prostate
DP	vas opening into epiphallus
E	epiphallus
EC	epiphallic caecum
EF	epiphallic flagellum
EP	opening of epiphallus into penis
G	ovotestis
GD	hermaphroditic duct
GG	albumen gland
GT	talon
H	heart
HA	auricle
HG	hindgut
HH	aorta
HP	ventricle
HV	principal pulmonary vein
I	intestine
IZ	stomach
J	jaw
K	kidney
KD	ureter
KX	ureteric pore
L	left shell lap of mantle
LP	pneumostome
MC	mantle collar
ML	left mantle lobe

N	nerve ring
O	esophagus
OG	salivary glands
OGD	salivary gland ducts
P	penis
PA	penial appendix
PC	penial caecum
PL	penial lobe
PP	penial pilaster
PR	penial retractor muscle
PS	penial sheath
PV	penial verge
PVO	vergic opening
S	spermatheca
SP	spermatophore
TE	ommatophore
TR	tentacular retractor
TV	rhinophore
UT	uterine section of spermoviduct
UV	free or post-uterine oviduct
UVO	opening of oviduct into vagina
V	vagina
VC	vaginal caecum
VD	vas deferens
VG	vaginal gland
VS	vaginal stimulator
W	dart apparatus
WB	dart
WG	dart gland
WM	mucous glands of dart apparatus
WP	papilla of dart apparatus
WR	retractor muscle of dart apparatus
WS	dart sac
X	carrefour
Y	atrium
YO	gonopore
Z	digestive gland